AGRICULTURAL ENGINEERING

Established 1920

This journal is owned, edited, and published monthly by the American Society of Agricultural Engineers.

Editorial and advertising departments at the executive office of the Society, Saint Joseph, Michigan. Publication office at Benton Harbor, Michigan.

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SUBSCRIPTION PRICE: To non-members of the A.S.A.E., $3.00 a year in the U. S. and possessions and in Americo-Spanish countries, $3.50 a year in Canada, and $4.00 a year in all other countries; to A.S.A.E. members anywhere, $2.00 a year. Single copies (current), 30 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

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EDITORIALS

A Work Remembered

A FINE tribute to the late A. H. Hoffman, for his pioneering work in the improvement of air cleaners for internal-combustion engines, is published in the British implement trade journal, "The Implement and Machinery Review," for March 1. The editor of that publication was reminded of the early history of air cleaners and their original development to protect the engines of farm tractors, by a news item to the effect that they had been found necessary to prevent excess wear in the engines of airplanes used in the current African desert campaign.

"It was Prof. Hoffman who first brought air cleaners to our notice, when he approached us direct in the matter and sent us the results of his investigations," the editor says in part. "There is no doubt about it, he did a tremendous amount of good for the farm tractor in this one respect alone.

"It is timely to recall, too, that Prof. Hoffman showed the remarkable difference there was then in the dust-removing capacity of different types of air cleaners. Some quite well-known patterns were proved to allow a substantial proportion of the dust in the air to pass through them, and, as a result, ideas on the subject were 'shaken up' in the most beneficial manner."

Prof. Hoffman was a member of the American Society of Agricultural Engineers from 1914 until the time of his passing in 1931, and did his work on air cleaners as research specialist in agricultural engineering at the University of California. This instance of his work being recalled for its present value across the Atlantic is an example of the fact that, in agricultural engineering as in other fields, when a man does a really fine piece of work there is no telling what uses it may be applied to in the future, how far its benefits may extend, or how long they may survive his mortal years.

We can see into the future only a little way and imperfectly, but we can put into our work the character of soundness that is apt to give it enduring as well as present value.

Technical Liberals and Conservatives

ORTHODOX thinking maintained for centuries the intellectual, economic, and spiritual blackout historically known as the dark ages. Light and progress returned when enough individuals dared, at the risk of their lives, to commit the heresy of unorthodox thinking.

We are fortunate to have in the American Society of Agricultural Engineers some unorthodox thinkers, some keen observers on the frontiers of the field, some highly original individuals, and some healthy discontent with things as they are, with specific situations, and with the rate and trend of progress, both within the A.S.A.E. and in the whole field of agricultural engineering which it represents.

Unfortunately some of these men feel that, because they are on the fringe of the group in their work or thought, their welcome and usefulness in the A.S.A.E. is limited, and that its usefulness as an agency through which to work toward progress as they see it is likewise circumscribed.

Probably there is opportunity for some improvement in mutual understanding and appreciation between what we might call the technical liberals and the technical conservatives in agricultural engineering.

Conservatives need to be constantly reminded that the source of progress is new ideas, different approaches, unprejudiced searching, and daring originality. They need to be reminded that most of the ideas and beliefs to which they may hold with pride as conservatives, have been generally considered at some former time to be not only liberal, but radical, absurd, and dangerous. They need to appreciate that their knowledge, their methods, their achievements are incomplete and imperfect. There is a lot of work still to be done in this world, and not all of it is along lines seen by conservatives. New generations will come along, and do some of it; if not with the blessing of the conservatives, then in spite of their opposition. The useful function of conservatism is not to stop progress but to guide it; not to oppose liberalism but to test its output; not to dampen the enthusiasm of liberals but to hold them to high standards.

Liberals, on the other hand, should not expect to be coddled and pampered. They need to be reminded that if anything they develop has value, it is not because it is new or liberal, but because it is sound. The merit of liberalism is not in the name but in results. Liberalism is not an end in itself, but may be used as a means to an end. All the liberal can reasonably ask is freedom to think, opportunity to work, and a fair hearing. He needs the intellectual honesty to face the fact that only a small percentage of liberal ideas survive the ultimate tests of time and application; that many of his own pet ideas may be partially or completely unsound. He needs the patience and self-discipline to do a lot of thinking; and to test his ideas first on a laboratory scale, and then on a pilot plant scale, before asking to have them applied on a large scale and at considerable expense. He needs to appreciate that conservatives have a background of experience which he can use as a guide, to save him from wasting a lot of time and effort on ideas already disproven. Additional evidence of the need of checking liberal ideas is the fact that liberals disagree among themselves, and offer a wide variety of approaches and solutions to any one problem. The distinguishing characteristic of a lunatic is that he accepts the products of his imagination without question. A true liberal may well aim to be his own severest critic. The most effective liberals are those who can accurately distinguish between the real lessons of experience and the unfounded caution and scepticism often associated with conservatism; who can utilize the one and avoid being discouraged by the other.

Liberalism is generally associated with youth, and conservatism with age. This gives conservatives the advantage of position and power to enforce their viewpoint. Liberals often have the offsetting advantage of ingenuity to get things done without position or power.

We need technical liberals as well as technical conservatives in agricultural engineering and the A.S.A.E. Let's make them feel welcome and at home, but on their honor to hold to high standards of technical and professional performance. Let's invite expression of their ideas and give them a respectful hearing with the understanding that the conservative element will not follow along like so many sheep but will be convinced only by strong scientific evidence. Let's put our conservatism on a sound technical footing and not be too ready to pour cold water on new propositions, or some will survive to expose our backwardness. Let's promote better mutual understanding of the strong and weak points of both liberalism and conservatism, as human tendencies subject to some degree of personal development and personal control. By giving some attention to the matter we can keep our liberalism free of insanity and our conservatism free of senility. Greatest progress will be made in agricultural engineering if we encourage a balanced development and cooperative application of the strong points of both.

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Machines Designed for Harvesting and Storing Grass Silage

By H. E. Besley and W. R. Humphries
MEMBER A.S.A.E.

HARVESTING and storing any hay or forage crop for silage involves the fundamental operations of cutting, gathering, hauling, chopping, and elevating. In some instances, operations may be combined. New machines which perform more than one operation generally change the order in which they are accomplished, for example, field choppers, which chop the crop in the field before it is hauled.

Cutting. The crop is generally cut with either a horse-drawn mower or one attached to a tractor and driven through the power take-off. For small operating crews, horse-drawn mowers are generally used. The tractor mower cutting a 6-ft swath, will keep three trucks and a loader busy. When the hauls are short, as from adjoining fields, two trucks may be sufficient to keep operations going continuously. Where the crop is to be loaded from the swath, care in cutting and placing it pays good dividends. If windrowing is necessary, a windrow attachment on the mower gives good results unless the crop is badly lodged (Fig. 1). The attachment may not give satisfaction on hillsides or when the crop is lodged. A number of farmers successfully use a standard grain binder for cutting their grass silage crop, particularly if it is timothy or one of the small grains. This method eliminates any need for a loader.

Gathering. Some farmers windrow the crop and then pitch it onto a wagon or truck. Pitching this crop, which weighs about three times as much as field cured hay, is an arduous task. If this work is to be lightened a hay loader is essential equipment. Loaders have been redesigned and improved so they give little trouble when handling green grass. Most of the green crop loaders will take the crop from either the swath or windrow. If yields are low, two or more swaths may be thrown together with a side-delivery rake to speed up loading operations. In fields with loose stones, the raking cylinder should be set to clear the stones, provided this can be done and still windrow the crop; otherwise, windrowing should be discontinued. Stones picked up with the grass cause trouble at the chopper. For short hauls, or where small trucks are used for hauling, it is frequently possible to get along without a man on the load. However, most farmers still prefer to have at least one man to build the load. If care is taken to build the load from front to rear, the work at the cutter may be somewhat easier. When gathering material from the swath, loaders have a tendency to pick up from adjacent swaths. This tendency once started may quickly build up, resulting in a clogged and possibly damaged machine. Fig. 2 illustrates a condition that is all too common on hillside operations where side slippage and pickup from the adjacent swath are serious.

Hauling. Hauling may be done with motor trucks, trailers, or wagons, but the wagon is used most. Motor trucks are preferred to speed up operations on long hauls. If trucks are used on hilly fields, a tractor is frequently necessary to assist with the loading. When dump trucks are available, it is possible to quickly leave the load beside the chopper and return to the field. This permits continuous operation with fewer vehicles.

Chopping. Most ensilage cutters are now equipped to handle green crops satisfactorily without a man at the machine to do the feeding. They work equally well, whether

A paper presented before a joint session of the Farm Structures and Power and Machinery Divisions at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 4, 1940. Journal series paper of the agricultural engineering department, New Jersey Agricultural Experiment Station, Rutgers University. Authors: Respectively, assistant agricultural engineer, New Jersey Agricultural Experiment Station, and chief engineering aide, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

Fig. 1 (Left) Windrow attachment of the swinging type fastened to the cutter bar of the mower. The position of the adjacent windrow is shown on the left. Fig. 2 (Right) Loader clogged with green oats. This trouble is serious when the loader tends to pick part of the adjacent swath, a condition prevalent when working on hillsides

the crop is pitched from the ground or the load. A man for feeding is almost a necessity when a tangled mass is dumped, or where it is difficult to pitch from a load in uniform small bunches. It is well to repeat that carefully building the load from front to rear will make unloading easier. Only one man is required to unload bundled material, an important point to remember when considering a binder for cutting.

Preservatives for the grass silage may be applied in several different ways. A simple gravity feed is used on most old cutters. The molasses barrel above the cutter is a common sight in the dairy counties of New Jersey (Fig. 3). The container above the cutter permits measuring the preservative for each load. When the preservative is molasses, it causes considerable mess on the feed table if it is mixed with the grass at, or ahead of, the feed roll. The newer cutters are equipped with pumps and special feeds, making it possible to draw the preservative from a drum on the ground and direct it upon the grass above the shear plate or at some other point in the fan housing. One manufacturer provides an arrangement for forcing the preservative by hose to the top of the delivery pipe and feeding it into the chopped material at the elbow.

Electric motors are generally used to drive the silo fillers at the New Jersey agricultural experiment station. Short belts are used with the motors and considerable slippage is evident with uneven feeding. To increase the belt tension and overcome the slippage, the motors at times have been cradled lower into the belt by the farm help with the result that one or two motor bearings have been burned out in a single filling season because of increased bearing pressure. Other troubles at the cutter have been experiencd when lost wrenches and iron bars got into the grass.

The usual admonitions to have sharp knives and close clearance on both knives and paddles have added significance when working with grass silage. Uniform feeding is generally more difficult with grass than with corn, and lack of uniformity increases the work of the cutting mechanism. Elevation of the cut grass is somewhat complicated by the addition of preservatives.

Field Choppers. There are now on the market at least two machines that pick up the green crop from a windrow, chop it, and elevate it into the hauling vehicle. These machines lighten the work, but at present the cost puts them out of reach of all except large-scale operators. A recent addition to field choppers is the small harvester patterned after the so-called baby combine. It serves as a mower, chopper, and loader. Such a machine should go a long way in reducing the cost and hard labor involved in the production of grass silage. Tests made in New Jersey with an experimental model during the past summer indicate that the outfit operated by two men can harvest from three to five tons of second-cutting alfalfa an hour. Later tests made elsewhere with an improved model showed much greater capacity.

In addition to eliminating much of the hard work in the field, this forage combine delivers the material in a form that is easy to handle at the silo. It may be unloaded with an ensilage fork with much less effort than is required to pitch long material. Fig. 4 shows how the field-chopped material was elevated with a regular silo filler without much falling through the table.

Elevators. Anticipating the perfection and acceptance of the forage combine, the development of an elevator of low power requirement is going on at the New Jersey Agricultural Experiment Station. This is part of the cooperative investigation on farm machinery now under way with the Bureau of Agricultural Chemistry and Engineering of the U. S. Department of Agriculture. Most any drag elevator with suitable feed could be adapted for this purpose if set out at the base. However, it seems more desirable to use one that stands vertical or nearly so and then leave it permanently in place, keeping in mind an optional arrangement whereby one elevator may serve two or more silos depending on the individual farm set-up.

An experimental elevator of the drag type, with flights enclosed, was built and erected first on a 42-ft silo and later on a 30-ft steel silo. Maple lifts 3x8 in, previously boiled in oil, were attached about 18 in apart, to a No. 52 malleable chain. It was found in operating the elevator that fast-moving lifts knock out considerable material when fed from the front either by gravity or from the feed table. Slower speeds reduced the throwing of the silage but introduced wedging difficulties. Performance of some promise was obtained by entirely enclosing the elevator at the bottom and feeding from the side, between the flights, above the point of enclosure. A metal housing was provided without clearance between the housing and travel of the lifts (Fig. 5). Using a 2-hp motor to drive the conveyor at a speed of 600 fpm, test loads were elevated at the rate of about one ton an hour, with an energy consumption of about one kilowatt per ton. With larger effective cross sections and suitable feed this capacity should be increased considerably.

Fig. 3 (Left) A simple gravity feed for molasses. Fig. 4 (Center) Unloading field-chopped alfalfa with an ensilage fork. Fig. 5 (Right) Experimental silage elevator, showing motor drive, lifts, and side feed

Needed Research on Southern Farm Buildings

By W. V. Hukill
MEMBER A.S.A.E.

WHAT are the subjects on which research can be most effectively applied to improve farm buildings in the South? There can be no general answer to that question. Questions that farmers ask about building problems have an important part in deciding what research would be fruitful. The Bureau of Agricultural Chemistry and Engineering receives and answers, as best it can, a considerable number of inquiries direct from farmers all over the country. These reflect individual problems encountered in construction and use of buildings, and the difficulties of actually attaining the structures needed. By selecting those from the southern states it is possible to get information on the relative importance of various questions from the point of view of southern farmers. Many of these inquiries may be answered with bulletins or other printed material and, it is gratifying to find, a large number are now taken care of by reference to plans in the U. S. D. A. southern plan service.

We have not attempted to make a detailed analysis of these letters but, aside from requests for plans themselves, there are a few general subjects which reappear constantly. These include moisture control, use of building materials, sanitation and the general requirements that must be met, such as, for example, in storage houses or in livestock buildings. While these subjects are more or less interrelated, each includes a number of items which should be included in any list of needed research. The larger problem of actually getting improvements on farms where they are needed is implied in all the inquiries and needs special attention.

FUNCTIONAL REQUIREMENTS AWAITING DEFINITION

Much work has been done and is being done on environmental requirements. In the storage of farm products, the optimum conditions of temperature, humidity, and air motion have been determined tentatively for many products, although work is still needed on curing treatments and other modifications in storage practice, such as CO_2 or other gas storage. The increasing use of freezing preservation and locker storage has resulted in much study of the temperature requirements of various products during freezing and storage. The work most needed now is reduction of these requirements to practical use by making suitable equipment available to farmers, and providing them with the technical, economic, and practical information that will permit adoption of freezing storage on a much larger scale.

The requirements for farm animals have been established only in a general way. The same is true regarding comfort conditions for farmhouses. A great deal more work needs to be done before questions about practical limits of temperature, humidity, and ventilation tolerances can be answered with complete satisfaction. Research along the lines of determining environmental requirements and finding how to meet them with economical structures and equipment, needs to be undertaken with the cooperation of the biological sciences. Studies should include effects of air stratification, drafts, and radiant heat exchange with hot or cold walls.

A paper presented before a meeting of the Southern Section of the American Society of Agricultural Engineers at Atlanta, Ga., February 6, 1941. Abridged. Author: Senior agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

Control of moisture is one of the general problems on which technical research is most needed. One difficulty in working out methods of moisture control is the lack of suitable instruments for measuring moisture content of various materials and vapor pressure or humidity of air. An instrument which could be used to measure vapor pressure in remote locations or in small enclosed spaces, with the same facility as, say, a thermocouple for measuring temperatures, would be an invaluable aid in opening the way for studies of moisture transfer and moisture control.

A large number of inquiries about preventing mildew and stale odors in houses or basements come from the southern states. In most cases some special conditions are associated with the difficulties. Certain places are apparently affected more than others, and frequently the trouble occurs only at certain seasons of the year. There are precautions that can be advised to reduce the likelihood of nuisance from dampness, but there is need for further study of its control.

MOISTURE ACCUMULATION IN STORED PRODUCTS

A recent inquiry about moisture control in the storage of sugar in a large warehouse furnishes an example of the difficulties in determining the source of dampness and eliminating its effects. This is not a farm example, but it illustrates the problem of moisture control as it frequently occurs. The warehouse, which stores about 500,000 bags of sugar annually, was built on piers, partly over water and partly over land. During certain seasons, the bags of sugar on part of the first floor became moist on the outside and the sugar was damaged. The inquirer wanted to know whether a one-inch coating of asphalt on the floor, in addition to wooden mats, could be expected to remedy the trouble. Certain suggestions were made, which partially solved the difficulties, and the manager was further advised to make observations of temperatures and humidities at critical points so that additional remedies could be applied. This case was typical in that only certain parts of the building seemed to give trouble and other parts, apparently equally exposed, were free from trouble.

In the storage of grain, the same situation is frequently observed, that is, certain parts of a bin will be found to be in good condition while in other places the grain is out of condition on account of high moisture content, even though the entire contents may have been uniform at the time it was stored. If the transfer of moisture were better understood, possibly it could be made to operate to advantage rather than to result in harmful accumulation.

The accumulation of moisture in insulated walls has been studied rather extensively and means for preventing it have been fairly well worked out. However, moisture transfer which accompanies small temperature gradients within hygroscopic materials and the absorption of vapor from the atmosphere offers a difficult research problem, but one which promises extremely useful results.

Another class of questions is about the use of native materials such as logs and stone. Their possibilities have not been fully exploited, partly because of lack of equipment for handling and working the heavy units, and partly because the advantages of these materials have been lost sight of. Buildings in which these materials are used would

be more common if the research agencies would develop methods and simple equipment to take advantage of their low cash cost. There are a large number of relatively new commercial materials available for building. Studies of ways of combining commercial and native materials for the most economical buildings would provide more satisfactory answers to farmers' requests for advice on their building problems. Means should be worked out for cooperative operation or community ownership of equipment such as mixers, saws, paint sprayers, etc., which might be too expensive to warrant its purchase for individual jobs.

Among the materials being tested in the Bureau's cooperative project on farmhouses with the University of Georgia are cottonseed hulls for insulation and concrete slab floors to eliminate pier construction. The hulls may be treated to make them fireproof. The cost for fireproofing materials is relatively low, and while considerable labor may be required in preparing them, this is not always a serious handicap, since on many farms spare time may be used. There are some problems involved in the use of concrete slab floors. These and many other materials not commonly used in southern farm buildings need only to be developed by research and experimental application to become important factors in reducing the cost or improving the condition of farmhouses and other buildings. Questions about the use of earth as a building material and about admixtures of asphalt and cement as stabilizers for adobe and other forms of earth construction are common. What we need, in order to answer them more satisfactorily, is research as to the practicability of different methods and the durability of earth buildings in various climates. An interesting series of tests on some of the characteristics of earth walls is under way at the National Bureau of Standards.

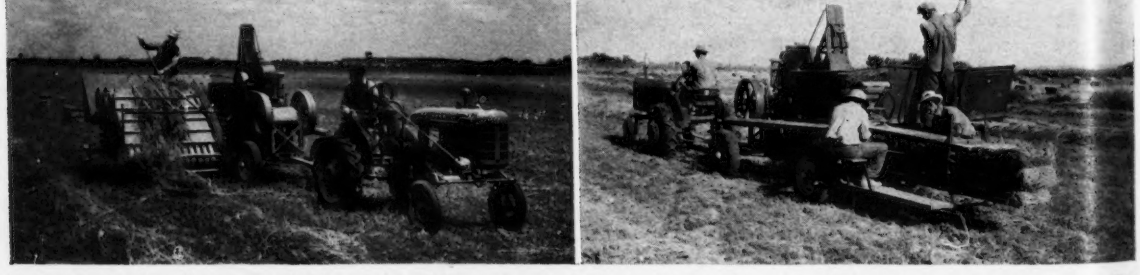
We receive a great many inquiries about water supply and sewage disposal. One common question is: "What chemical can I put in my septic tank to dissolve the solid material that accumulates and has to be cleaned out?" Such questions reveal a faith in science that is embarrassing when we consider that various authorities cannot agree on types and details of sanitary equipment that should be used in given conditions. Lack of complete agreement is to be expected, but it should stimulate efforts to determine the practicability of various types of equipment. Probably the research most needed in farm sanitation is that which might show more clearly the most important things to be done in providing sanitary facilities at low cost.

The technical problems that have been mentioned are representative of those suggested by frequent inquiries. All are being studied more or less, and progress can be expected to continue.

All research on farm building is intended to promote the well-being of farm people and increase the effectiveness of their efforts at production. It is not serving its purpose unless it contributes to these objectives. The finest technical results are largely lost if they are not translated to practical use on farms, either directly or indirectly. Everyone recognizes this, but in practice it is frequently overlooked. The present condition of farm buildings throughout the country testifies that the results of research on its present scale are either not capable of meeting the farmers' problems, or they have not been put in usable form. This suggests that, in addition to the innumerable technical subjects of building research, there is a broad problem of actually getting good buildings on farms. This is a problem which needs attention entirely apart from, or in addition to, study of the technical details that are a part of it. In his annual report for 1934 the Secretary of Agriculture said, "Heretofore farm savings have largely gone back into the farm to increase production. It would be sound economy to put an increased proportion into the home. Such a course, besides raising the farm standard of living, would harmonize with the need for controlling production."

What can be done to reverse the trend toward poorer and poorer farm buildings? It is evident that the present small expenditures for technical research and extension are not succeeding. The problem of making them adequately effective is still facing us. As in attacking many difficult problems, one of the hardest jobs is finding a place to start. In fact, starts have been made in a number of places. There are, for example, the small-scale projects in Arkansas, Alabama, and Wisconsin. In each case attempts are made to combine research, education, and use of home resources to provide improved building with a minimum of cash outlay. The results of these small-scale projects indicate that a program might be devised whereby the general condition of farmhouses and other buildings could be improved tremendously within the next few years. Such a program would call for the combined application of extension and research methods and would utilize the energy and resources of farm people.

Certainly any constructive effort leading to unified attack on the general farm building problem is timely. If the present trend is permitted to continue, and there is no indication that it will not be, before long it will be imperative to take heroic measures or else be content with a perpetual state of inadequate housing for farm products, farm animals, and farm families. No doubt, at the end of the acute defense emergency in which we find ourselves, if not before, a large-scale program for the improvement of farm buildings may be demanded. Whether this happens or not, farm building specialists would do well to devote part of their efforts to studying possibilities for combining their forces in such a way that farmers may actually be able to build the structures essential to agriculture.



Front and rear views of a new small pick-up baler. Baling equipment of this size brings within reach of the average size livestock farm another opportunity to lower production costs

Aids to Judgment in Irrigation

By F. E. Staebner
MEMBER A.S.A.E.

As much as it has seemed and still seems necessary to evaluate various factors connected with irrigation practice in order to preserve records of irrigation activities for our own future use and to transmit ideas to others, and in spite of much excellent work that has been done in developing the "science" of irrigation, under a great many conditions and for a goodly number of crops, it is still necessary, to a large extent, to handle irrigation as an art rather than as a science.

In the operating of any farm irrigation venture, whether water is obtained from a public or a semipublic source, or from a privately owned water supply, the matter of when to irrigate is constantly coming up for decision. Although it is definitely troublesome in the arid states of the West, it proves much more troublesome to the operators of supplemental irrigation systems in the humid East. In the latter area, the effect of the frequent showers of varying amount, duration, and intensity is most disturbing in settling upon just how much moisture is available to crops at any time. Further, the clouds in the sky, which may be just clouds or may be forerunners of real rain, add a constant element of uncertainty. The temptation to avoid the work and expense of getting ready to irrigate and irrigating is great with a group of hope-inspiring clouds up above. I worked all one season in a locality where a number of farmers were able to irrigate with temporary setups and were quite interested in the possibilities, but although that growing season proved to be very dry, only three of them went to the effort and expense to begin irrigation early enough in the season to do them appreciable good.

DEMAND FOR IRRIGATION NEED INDICATOR

For any farmer who is equipped to irrigate, but particularly for those in humid territory, it is desirable that he have some ready and dependable means of reinforcing his judgment on when it is time to irrigate, and that the indication be made before the growth of his crop has been checked. It should preferably be an inexpensive, simply maintained device or indicator, and one that gives an indication of the condition at the moment of observation. As I know of no such single indicator, I am going to call attention to certain things that may be used to help in reaching a decision about when to irrigate, in advance of the occurrence of serious retardation of a growing crop.

First, of course, is a record of the actual rainfall as it occurs. It is not conclusive, because in different cases different proportions of rains are added to the available moisture in the soil. This is affected not only by the intensity of the rain itself, but also by the slope of the ground, the condition of cultivation of the ground surface, the amount and type of vegetation, the inclination of the falling raindrops as related to the slope of the ground, and even, in some instances, by the temperature of the ground and of the raindrops themselves. As stated, the record of rainfall is an imperfect guide, but one that should not be entirely overlooked. Unless overlying a perched water table or an area fed by underground seepage from higher lands, a field is unlikely to maintain its moisture in a period of no rainfall.

There is one definite indicator always present, namely, the plant itself. While ultimately accurate, many plants are not sufficiently quick-acting in presenting visible evidence of a water deficit. Before the symptoms of lack of water are noticeable to the eye, considerable damage may have already taken place. This regardless of whether the plant in question shows lack of moisture by wilting, by curling or dropping of the leaves, or by dropping of the fruit.

PLANT INDICATIONS OF WATER SHORTAGE

Using the plant as a basis and introducing measurable quantities instead of just apparent tendencies, Magness, Degman, and Furr[4]* have shown, by measuring the growing fruit, that after the first 6 or 8 weeks the rate of increase in volume of apples in Maryland is reduced if the moisture supply runs short. They state that this practice "might be very helpful to the orchardist who is starting in to practice irrigation as it gives an excellent index as to when his particular trees need additional moisture."

Furr and Taylor[2], working with lemon fruits in California, have shown, likewise by measurements of the size of the growing fruits, that with that crop also a water deficit for the trees results in a slowing up of the growth rate of the fruit, and that the application of water was again followed by an increase in the growth rate. They found that the difference in growth rate just before and just after irrigation was a measure of the water deficit which had occurred. They recommend, however, that growth measurements be used as a check on the adequacy of a given irrigation practice, rather than as a means of determining in advance when irrigation water should be applied. It is conceivable that unfavorable conditions other than water deficit might cause a reduction in rate of increase in size of fruit. However, it would seem that if semiweekly measurements of a number of tagged fruits in an orchard could be expected to show when rate of growth began to fall off, it might at least arouse a suspicion that irrigation was needed.

It is likely that similar studies would show, in the case of other fruiting crops, a check in fruit growth with soil water deficit, and that actual measurements might have a use outside the field of the orchard fruits. At that, however, the method does not seem applicable to determining a check in the growth of leafy vegetables or of tubers, both of which are widely irrigated.

Obviously, some other means is needed of determining at least approximately when it is time to irrigate, and for this we naturally turn to articles or apparatus more or less of the instrument type. The first one that occurs to us as a possible guide to irrigation practice is the atmometer[3]. A simple piece of equipment, it consists commonly of a hollow, porous porcelain piece, preferably a sphere, connected by a suitable tube or pipe to a water reservoir. As water evaporates from the exposed surface of the porous porcelain sphere, a corresponding quantity is supplied from the reservoir. From time to time the reservoir is refilled to the

A paper presented at a joint session of the Rural Electric and Soil and Water Conservation Divisions at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 5, 1940.
Author: Drainage engineer, Bureau of Plant Industry, U. S. Department of Agriculture.

*Superscript figures refer to bibliography appended to this paper.

starting level and the quantity that has evaporated in the interval is thus determined.

The atmometer should not be thought of as an instrument of precision, and the porcelain spheres, particularly the white ones, require frequent cleaning to remove dust accumulations or chemical concentrations, but mostly algae. Black spheres seem to collect much less algal growth than white ones. As commonly used, atmometers are operated in pairs, one with a white, the other with a black porcelain sphere, and it is considered desirable to have three or more pairs of instruments in replication and retire one pair in rotation every month or so.

In most cases, atmometers are equipped with nonreturn valves so that they will pass moisture out as a result of evaporative forces, but will not return rainfall to the water reservoir from which they are supplied. Porcelain atmometers are believed to respond more to wind fluctuation than most plants, and black ones to respond more than many plants do to sunshine fluctuations. Where frequent readings and close accuracy are wanted, atmometers, as ordinarily used, are time-consuming instruments because of the several sets of instruments required, with the consequent time used up in frequent refilling, the amount of cleaning of the spheres that may be necessary, and the need for restandardization at relatively short intervals.

In spite of their shortcomings, atmometers are widely used in ecological investigations. We grant that ordinary irrigation farmers cannot take time or allow their helpers time to care for a large enough battery of atmometers to secure highly accurate determinations of atmospheric evaporating power. However, I raise the question whether, with some simplifications in setup, or possibly only in handling, they might not be useful as guides to irrigation until some better device is brought out. Results would be crude and not scientific, but would it not be worth while to connect an atmometer sphere to a reservoir of such size that in continued dry weather the accumulated loss of water to a certain low level would indicate that the plants during the same interval had lost enough water so that a fresh supply to their roots might probably be desirable?

Furthermore, how about that nonreturn valve in the connecting tube? Suppose we left it out and let rainfall be returned to the reservoir. Still crude, I grant, but might we not thereby roughly carry our reservoir somewhat on the basis of the soil, only getting a little increased moisture from a short intense rain, but like the soil, getting much more from a long, slow, gentle rain?

I am only asking, but if it could be done, with relatively little equipment and relatively little effort, a guide, although an imperfect one, might be available to help the farmer's judgment when in doubt. Any such device, although perhaps filling a need temporarily, must certainly be discarded when a better one comes along.

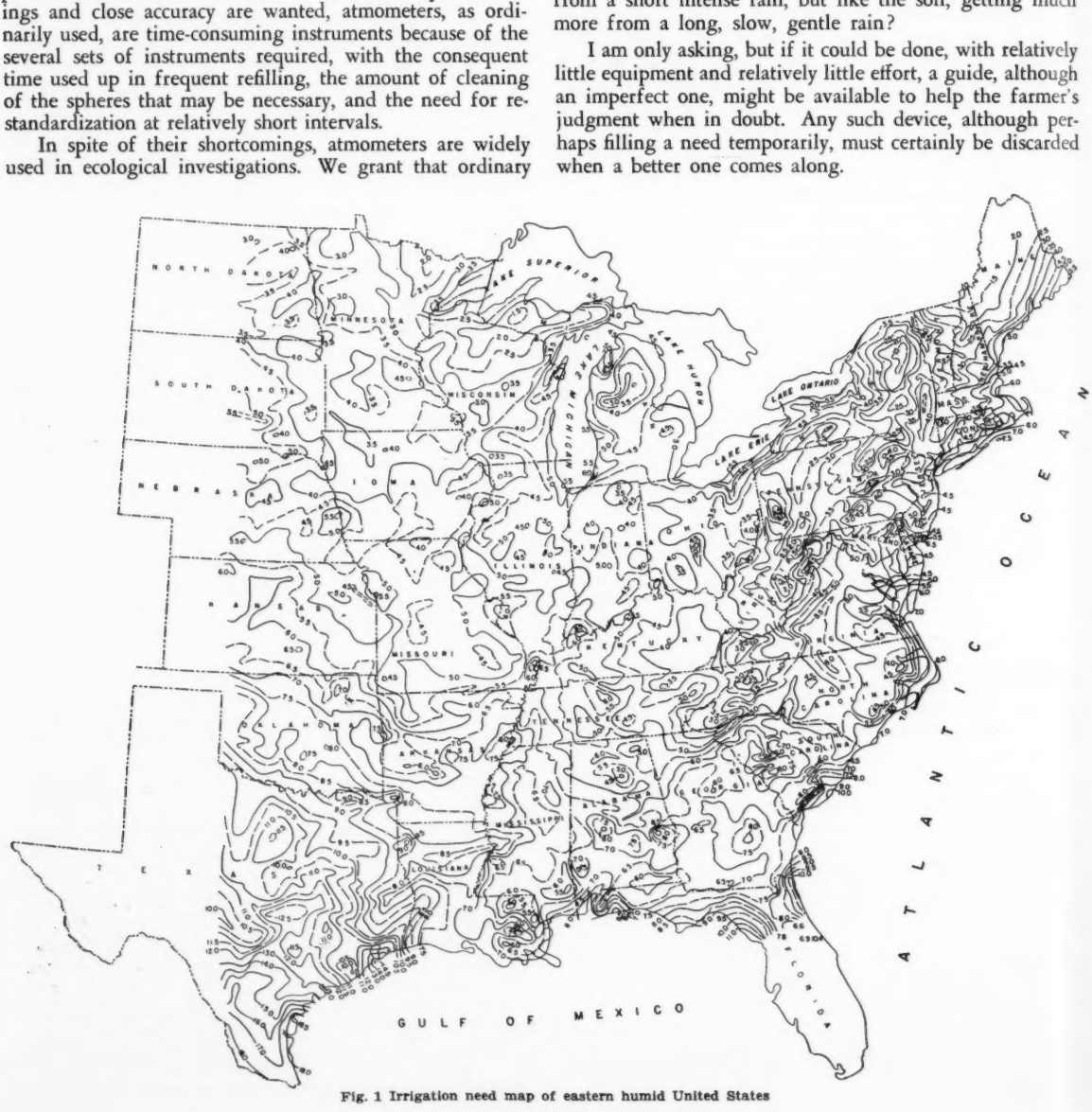


Fig. 1 Irrigation need map of eastern humid United States

Turning to guides based on the soil, our first thought is soil moisture. A great deal of work has been done with soil moisture, and as a result soil moisture tests are used as a guide as to when to irrigate. In fact, some commercial laboratories in the West arrange to test soil moisture for commercial orchardists. However, many samples seem to be needed to determine with even fair accuracy the average soil moisture condition of a field or orchard, and, owing to the time consumed in processing the samples, the information is never obtained until the conditions have changed.

From the standpoint of being a useful commercial improvement in soil moisture determination our attention is directed to the moisture availameter developed by R. B. Allyn of the Bureau of Plant Industry, formerly of the Bureau of Agricultural Engineering, and R. A. Work of the Soil Conservation Service, both of the U. S. Department of Agriculture[12]. The apparatus appears to be a completely developed, practical device, applicable to any field where soil samples may readily be taken with the ordinary King or Viehmeyer soil sampling tube.

PRESSURE AND TENSION INDICATORS OF SOIL MOISTURE

However, some irrigated fields are too stony for successful use of the soil tube and to get a clue to the real need for irrigation in such a spot, some other type of device must be used. In such case instruments arranged to measure the tension with which water is held in the soil seem to have a certain applicability. The Richards tensiometer[5,6,7] and the Rogers soil moisture meter[8,9,11] come in this classification. They depend upon the forces acting in the soil to remove water from a buried porcelain jar or bottle. As the surrounding soil loses moisture in a drying period, tension forces are set up which try to remove the water from within the porous bottle. This establishes a partial vacuum therein. The resulting pressure deficit is transmitted by means of small metal tubing to a suitable vacuum gage of either the mercury manometer or the Bourdon type. When the soil surrounding the porous bottle is moistened, conditions are reversed, the vacuum within the bottle is lessened, and the gage reading drops.

These gages are limited to suction forces of approximately one atmosphere (actually somewhat less). As it appears that plant roots can withdraw water from soil against resistances of many times one atmosphere, this type of gage is largely discredited for this service by many workers in the irrigation field. However, I wonder if, with proper regard for this limitation, these instruments cannot still be used for this purpose. Why cannot this limitation be overcome by proper placing of the porous cup?

With any crop, the most rapid withdrawal of soil moisture may be expected from the zone or depth layer of greatest root concentration. A porous cup located in that zone or depth layer would undoubtedly encounter suction forces beyond the limit of its capacity very early in any drying period. However, with the rapid withdrawal of moisture and the development of high suction or tension forces in that layer, some readjustment of moisture and of tension forces would also occur in the lower layers. The withdrawal of moisture, though, would be less rapid and the tension forces less strong in successively lower layers of soil, assuming no rainfall or irrigation, until the average condition within the root zone reaches the wilting point or any other decreased moisture content at which it is desired that irrigation be undertaken.

Now at this same time, with the successively lower tensions in successively lower layers, it only seems necessary to place the porous cups at some level or depth where any desired gage reading, say 50 cm, indicates that the soil in the layers of the root zone is dry enough to warrant watering. To be sure, the indicator will not be precise, because under some conditions the lag in moisture and tension adjustments from root zone to porous cup depth will be greater than in others. However, it would appear that useful, practical approximate depth adjustment would be possible, although it is probably easier to place the porous cup at a suitable depth and readjust one's mind to the reading that, for that setting, indicates the need for irrigation. For commercial applications it is probable that the Bourdon type of gage should be used rather than a mercury manometer. Probably several should be used for each field.

The preceding discussion indicating that water is held by the soil grains at lesser and lesser tensions as one goes to lower and lower depth layers below the zone of greatest root concentration, may appear to be written only for localities with a permanent ground-water table within capillary contact with the surface soil. However, it is believed that it also applies to any irrigated soil, provided the location of the porous cup, the point from which the tension readings are secured, is not below the depth of wetting due to irrigation. In part, again, similar moisture and tension adjustments must take place as one goes away from the area of greatest root concentration in any direction—even horizontally. The porous cup, for such an instrument intended to be used as discussed above, could be placed at the depth corresponding to the center of greatest root concentration, but somewhere in the outer fringe of important moisture adjustment. Selecting such a suitable place for the porous cup would be more difficult than setting it in a lower layer.

ELECTRICAL RESISTANCE GROUND-WATER METER

Another type of instrument that appears to have a field of usefulness in determining when to irrigate is the electrical resistance type which uses electrodes permanently encased in gypsum blocks buried in the soil. This method was developed by Dr. G. J. Bouyoucos[1] of Michigan State College. It depends upon the theory that gypsum blocks will take up and release moisture so as to stay more or less closely in equilibrium with the surrounding soil and that the electrical resistance of the block will vary inversely as its moisture content. Readings are made by balancing a somewhat special type of Wheatstone bridge with the gypsum block in one circuit. The apparatus has been available for only a short time, but seems to offer a good deal of promise. It is not limited to fairly moist soil as are the porous cup instruments discussed above, but covers the whole range of ordinary moisture content from saturation to very dry. Its greatest drawback so far apparent is cost.

Another problem related to irrigation in the humid and semihumid areas is the one of deciding, in advance of any construction, if it is worth while to get equipped to irrigate at all. There are many angles to this problem and a complete answer, taking account of all the many factors, is not possible. However, if the rainfall during the growing season in any area is normally adequate and well distributed to meet the needs of plant growth the installation of irrigation equipment is not warranted and there is no object in undertaking the practice no matter how favorable other factors appear to be nor how serious any single drought period may seem. In an effort to evaluate the relative need for irrigation in different localities as indicated by average rainfall distribution over a long period, generally thirty years, the U. S. Department of Agriculture, through the cooperation of several agencies has compiled a map of the Eastern humid section of the United States, indicating irrigation need as developed from the rainfall records. This map, which includes all of the *(Continued on page 136)*

Practical Aspects of Farm Crop Residues

By L. R. Clausen
MEMBER A.S.A.E.

I SPEAK to you from the standpoint of an engineer, a manufacturer, and a farmer, because I own and operate a farm, and naturally feel that all three of these points of view must be presented and considered in connection with the subject of farm crop residues.

My first thought in this matter is that we should all remember that the farmer is not farming for the purpose of producing residues or wastes, but is farming for the purpose of producing crops and possibly converting them into milk or beef or other similar finished products before marketing. In any case, his large and primary interest is to produce these crops, and sustain himself, his family, and his farm operations on a sound operating and economic basis. He is not farming for the purpose of producing residues, and anything of this nature must be a relatively small factor and side issue in his operations. As a matter of fact, very few farmers would be willing to allow these so-called residues to leave the farm, because they would much prefer to put them back into the soil to maintain its tilth and fertility.

STRAW AS A MARKETABLE CROP RESIDUE

We are reduced, therefore, in the discussion of farm residues, to those few farmers who have residues they are willing to sell, say, for example, straw from grains such as wheat, oats, and barley, or a certain percentage of corn stalks or flax straw which can be used for special purposes. There may be other residues, such as bagasse from sugar cane operations, which is a very limited and local product. It appears at the present moment that straw from various kinds of grains is the principal residue which we may discuss. In relation to this, it seems to me that there is no particular problem.

The market for straw is rather limited. In the first place, a relatively small number of straw paper manufacturers desire to purchase maybe one-half or three-quarters of a million tons or thereabouts, but beyond that there does not seem to be much of a market at the present time.

There is no problem involved as far as the farmer is concerned, or even the industry, because there are plenty of machines on the market today to handle this straw residue economically and efficiently. It can be baled out of the straw stack if the farmer is using a binder or threshing machine, or it can be picked up from the windrow by a pick-up baler and put into bales at a minimum cost and in a clean condition with a very limited amount of chaff or dirt.

So far as I personally have been able to understand the problem of straw recovery, it is thoroughly solved, and there is nothing to be done except for the straw buyer to go around and solicit a supply from farmers in districts that are acceptable from the standpoint of transportation to the strawboard mills.

At this point I want to present another phase of this situation which must be considered. Inasmuch as the farmer is not in the business of raising residues, it is apparent that from a commercial and economic standpoint, the buyers and users of residues must look to those farmers who desire to sell residues, and who at the same time have the machinery for their regular crops which will handle the residues. The farmer cannot afford to buy a machine for the purpose of handling residues; he buys it usually for the purpose of handling crops and then, if this same machinery will handle residues, here is the opportunity for the straw or residue buyer to secure his supply. It has been demonstrated that the same machinery which will produce the highest quality of hay will also take care of the matter of gathering and packaging the straw. It has been shown that if real quality hay is desired, it must be first put in a windrow in a certain manner and then picked up out of the windrow and handled in a satisfactory manner, namely, by baling if the farmer desires to maintain the highest quality; and this process must be carried on before the hay has lost its color or its leaves, if the farmer is to maintain and preserve quality and feeding value. This can all be done by modern hay machinery, using mowers, side-delivery rakes and pick-up balers of the latest type.

It has been demonstrated that the critical moisture point for hay stored in bulk in the stack or in the barn is about 15 per cent, if color and feed value are to be maintained. It has also been demonstrated that hay can be baled and stored safely with moisture up to 24 per cent. This is the margin that makes it possible to produce the highest quality of hay by means of the pick-up baler method. The extra time required to reduce moisture from 24 down to 14 per cent may be two or three times the period required to reduce the moisture down to 24 per cent, a safe point for baling. This extra time is what destroys the color and creates loss of leaves and often runs the farmer into storms and other weather conditions which create loss of hay and loss of feeding value. Hay properly handled with the latest type of machine can be of the highest quality and at the same time represent the lowest possible expense for cutting, handling, and storage.

This point is mentioned because the same pick-up baler which makes the highest quality of hay will handle a residue, such as straw, with the greatest economy and efficiency, and put it in the shipping package that permits transportation at the lowest cost to some point of utilization. You may see from this that there is no real problem involved in the handling of straw.

OTHER FIBER POSSIBILITIES

As to corn stalks, there is much question, because there undoubtedly will have to be a substantial amount of experimental work done in regard to the moisture content of the stalks for baling, storage, and usage, before we can know just when to recover corn stalks for industrial use.

Some special mention may be made of flax straw and its industrial uses. It appears that recently the supply of cigarette paper has been cut off or reduced, and that the paper mills which specialize in this paper are seeking new sources of raw material; that flax straw or flax tow is a desirable raw material, and that the market will justify shipping the tow for long distances to the mills in the southeastern part of the country where cigarette paper is made. This will create an increasing market for flax straw which can be handled and converted into tow at the local mills in the flax districts before shipping *(Continued on page 134)*

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 3, 1940. Author: President, J. I. Case Co.

Housing Requirements for Curing Tobacco

By J. M. Carr

WITH certain exceptions, the quality of most farm crops is fixed in the field and the primary object of housing and storage is the preservation of this quality until the crop can be consumed. Only the potential quality of tobacco is developed in the field. Final value is entirely dependent upon the manner in which it is handled after it is harvested. Tobacco of all types is harvested in a green state, and the quality fixed by curing. This process involves dehydration under controlled conditions to bring out certain characteristics of the leaf. Curing requires specially constructed buildings, the types of which vary with the type of tobacco being produced. After curing has been completed, the cured leaf must be bulked down and aged or sweated to bring out its full value. With most types, the first stages of this process take place on the farm.

Cured tobacco is highly sensitive to heat, light, and moisture, which makes it desirable that it be stored and handled in buildings in which atmospheric conditions are controllable, or at least are not highly variable. Housing facilities for this crop must, therefore, be considered units of a processing plant. Proper housing facilities greatly reduce the hazards of curing and processing, and are a much needed part of the farm building program in the tobacco-growing areas of the South.

CURING PROCESSES INFLUENCE STRUCTURAL REQUIREMENTS

There are only three distinct curing processes used in the United States, although there may be slight variations of each process as it is adapted to different types of tobacco. Flue-cured, or bright cigarette tobacco, makes up approximately 60 per cent of the total production of the United States. About 32 per cent of the total production is cured by the air-curing process, as represented by the burley, cigar, Maryland, and certain other types. The remaining 8 per cent is fire-cured and is typified by the Virginia and Kentucky-Tennessee dark-fired types.

Flue curing is comparatively rapid, requiring from 74 to 100 hr for the complete process, and is accomplished by a somewhat complicated schedule of heat and air control. Briefly, this process requires fermenting the leaf for 30 to 40 hr under high humidity conditions, with temperatures ranging from 90 to 100 F (degrees Fahrenheit). After the desired color has been developed by fermenting, the leaf is dehydrated by air circulation and increased temperatures. The maximum temperatures used vary, but buildings used for this process should be constructed so as to carry 200 F with safety. These barns vary from 16x16 to 20x20 ft square, with walls that are comparatively air tight. Openings for ventilation may or may not be provided in the foundations and roofs of these barns. The heating system is usually a crudely constructed brick or rock furnace, or furnace with a system of flues completely encircling the barn on the inside. In recent years some attempt has been made to adopt more modern heating systems with coal and oil as fuels. Few of these attempts are improvements over the old system. Most plans and blueprints available are based on what is being used and are not the result of any study of the problems involved in this process. There is serious need of a study of the practical engineering requirements of flue-curing tobacco barns. For obvious reasons, economy and simplicity must be the watchwords in any improvements that are made.

With the rapid accumulating store of information on air conditioning and heating, it should not be difficult to apply some basic principles to curing tobacco, without a huge outlay for complicated machinery and controls. Flue-curing barns should be well insulated, yet the nearest approaches we have are the old log barn daubed with clay, and a somewhat more modern frame structure consisting of two one-inch board walls with tarred felt building paper between. The log barns furnish well-insulated walls, but require annual repair and deteriorate rapidly, especially in the Coastal Plain area where humidity is high. Loss of heat by radiation in windy weather is a serious fault of the frame buildings. It is quite evident that some economical form of insulating material could be used to great advantage in these buildings. In the drying stage of the flue-curing process, convection is the only means now used to circulate heat through the green leaf. Since approximately 3000 lb of water must be driven from the average barn of tobacco in approximately 40 hr, more information is needed on the type, size, location, and manipulation of air intakes and outlets necessary to make the most effective use of established principles of drying.

With the crude heating systems now used, the distribution of heat is often poor, resulting in the frequent formation of "chimneys." These so-called chimneys are caused by a concentration of heat or draft in one part of the barn, which dries the adjacent tobacco quickly, creating an opening through the tobacco to the roof of the barn. Once such a chimney forms, it serves as an outlet for heat as fast as it is generated, making it difficult to dry the remaining part of the cure. Some simple system of heat distribution, or an arrangement of the present system on more scientific principles would save much fuel and many hours of labor.

FIRE HAZARD IN FLUE CURING

The high temperature used in the final stages of curing, together with the highly inflammable nature of the dry leaf, forms an everpresent fire hazard in flue-curing barns. This hazard is often increased by lack of proper attention to certain structural details. Some of these faults are insufficient clearance between furnace and barn, improper construction of furnaces which results in their collapse at high temperature, and placing the lower tiers so low that the leaf hangs dangerously close to the furnace. Correction of these faults will reduce the fire hazard but will not eliminate carelessness which is the greatest cause of fires in flue-curing barns. Thus it is evident that the flue-curing of tobacco becomes a complication of housing, heating, and air-conditioning problems. Cooperative research work now in progress on some of these problems by the agricultural experiment stations and the U. S. Department of Agriculture doubtless will yield results of much value, and it is hoped that eventually the major problems involved will be satisfactorily solved.

While the potential quality of flue-cured tobacco is fixed in the curing barn, storage conditions have much to do with final quality. The cured leaf is not stable and cannot be

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A paper presented before a meeting of the Southern Section of the American Society of Agricultural Engineers at Atlanta, Ga., February 6, 1941. Author: Agent, Bureau of Plant Industry, U. S. Department of Agriculture.

subjected to widely variable heat and moisture conditions without serious deterioration. Strong or direct light will also reduce the value of the cure by bleaching out the color. Comparatively few tobacco farmers have space well suited for storing tobacco. Usually some makeshift such as a part of the dwelling in which the farmer lives, the corn crib, or a vacant tenant house is used.

In planning the construction of tobacco storage houses or "pack barns" other storage requirements of the farm should be kept in mind. Since these buildings must be tight and weather-proof, and are used for tobacco only three or four months each year, they serve as ideal storage houses for other farm crops. The type of material used for construction does not matter so long as an air-tight wall is obtained. A frame building of double-wall construction with building paper between serves nicely. Insulation is not necessary, except overhead to reduce heat transfer through the roof. This insulation may take the form of a second story or half story which can be used to excellent advantage for crops not affected by heat.

Since quality is correlated so closely with color, all grading must be done in a natural, indirect light that will reflect all colors in their true value. To obtain proper lighting, orientation of the building and window arrangement becomes an important part of construction. Buildings running east and west with all windows on the north side give ideal light for grading. Windows should be spaced so as to give uniform light along the entire north side of the building. This enables a large number of workers to grade at the same time and also permits a rapid change of air when desirable for casing or drying. Light-proof shutters to exclude all light from windows are desirable, although shades or curtains on the inside may be used. In sections where tobacco is handled and sold during the fall and winter months, ordering or casing basements are necessary. In the Coastal Plain area, where tobacco is usually handled in August and September when the weather is warm and the humidity high, these basements are rarely needed.

The air-curing process used in producing cigar wrapper, filler and binder, burley, Maryland, and the dark air-cured tobaccos, requires a much longer curing period than flue-curing. The minimum time required is approximately 30 days, and where the stalk is cut, several months may be required. It is therefore obvious that air-curing space must be sufficient for the entire crop at one time, while flue-curing barns may be used for as many as eight curings in one season. These air-curing barns vary in size according to acreage, but often run as large as 40x120 ft. Due to the size of these structures, there is serious conflict between the large amount of unobstructed space required for efficient loading, and the heavy bracing necessary to prevent their collapse in periods of high winds. The fact that these conflicting requirements form a serious problem was forcibly brought to attention by the heavy loss of curing barns in the Connecticut Valley caused by wind in 1938. Since no artificial heat is used, except in periods of high humidity, insulation is not required. However, numerous large shutters or ventilators on the sides are necessary for the control of humidity within the barn. Since light bleaches out the leaf near these shutters when they are open, considerable loss of tobacco results. An arrangement whereby air could be admitted freely without the admission of light would do away with this loss. As with flue-cured tobacco, air circulation is a serious problem in these barns. Dead air spaces prevent drying and in periods of high humidity cause mold and decay commonly known as "house burn" or "pole rot".

Tobacco housing is well within the field of air-conditioning engineering and already some experimental work has been undertaken in this field. However, we must remember that the value of the crop does not permit a large outlay for equipment. The practical needs of tobacco housing may be summarized as the need for a more scientific application of what is already known of insulating, heating, and lighting, without the use of expensive equipment and complicated controls.

Practical Aspects of Farm Crop Residues

(Continued from page 132)

the tow to the paper mills. The flax straw is sufficiently valuable so that it can be hauled the relatively short distance to the tow mills. It appears that in the Red River Valley, for example, there are about 30 lb of tow or fiber per 100 lb of flax straw as it comes from the field. The tow mills are willing to pay $5 or $6 a ton for baled flax straw. This is sufficient, with the modern type of baler, to make it profitable for the farmer to bale and either haul or ship his baled straw to the tow mill with flax straw running 400 or 500 lb per acre. Even with an inexperienced crew, with the latest type of balers, 17 to 20 tons of straw can be recovered or baled in a day. This represents a value on the farm of $55 to $60 for the day's work, with an operating cost for labor, fuel, lubricants, baling wire, etc., for the entire output of less than $18. This is acceptable to the farmer and makes it a profitable operation. Experiments this year in the Red River Valley have demonstrated that these figures are conservative and can be realized.

The problem, so far as handling flax straw, is solved, so little more need be said about it. Undoubtedly the commercial interests involved will proceed along orderly lines to secure whatever supply of straw they require for their needs.

EDITOR'S NOTE: Mr. Clausen's remarks constitute a distinct contribution to a developing orientation of residue collection in relation to the whole field of agricultural engineering problems and opportunities. Since it is a common human failing to get sidetracked from main issues and objectives, we consider especially timely his emphasis on the fact that farmers are not in business to produce crop residues, and that agricultural engineers can help farmers most in connection with their principal activities.

Improving the collection and use of crop residues to reduce waste is comparable to the problem of reducing waste in other industries. Waste is an incidental to main production operations and operating considerations. Its reduction is best considered as a phase of improving the efficiency of the main operations. Any attempt to reduce some particular waste without due consideration to main production objectives is apt to defeat its purpose by introducing or increasing other wastes which neutralize the effect of any specific saving achieved.

Reduction of waste is important, however, from the standpoint that any overall saving realized, while small in relation to total volume of business, may be relatively large as an influence on margin between profit and loss.

With characteristic frankness and sincerity, Mr. Clausen differs with some other agricultural engineers as to the extent of the potential market for crop residues, their fertilizer or land-conditioning values, and the extent of engineering opportunities to improve the economy with which they may be collected and delivered in condition for industrial use.

For the convenience of readers who may want to make a parallel study of this and other viewpoints on the subject, we suggest the following references in other issues of AGRICULTURAL ENGINEERING:

Beasley, R. P. Utilization of farm residues. March 1941.

Gray, R. B. Equipment, methods, and costs of collecting farm crop residues. February 1941.

Davidson, J. Brownlee. Equipment, methods, and costs of collecting corn stalks. February 1941.

Davidson, J. B., Fletcher, L. J., Lathrop, E. C., and Miller, Harry. The place of agricultural engineers in farm chemurgic development. September 1940.

Lathrop, E. C. The place of engineering in a program of farm waste utilization. January 1940.

Step-Up in Rural Electrification Technology Needed

By S. P. Lyle
FELLOW A.S.A.E.

OVER two million farms are now connected with electric service, but over twice that many farm families, in all probability, are looking forward to discover when and how it may reach them. How shall we measure progress in rural electrification? By the increasing number who are receiving electricity, or by the still more rapidly increasing number who look forward with the hope of receiving it? Certainly expectation precedes realization, and with reference to rural electrification expectant interest seems well warranted, for increases in the number of new consumer connections in 1940 both for cooperatives financed by the Rural Electrification Administration and for public and other utilities are close to the high record of 1939.

Rural electrification, however, is also growing in technology, exhibiting those evidences of vitality which we have seen always in growing industries, such as in its parent electric power industry, or the transportation industry, or the communications industry. As long as it can improve its service to agriculture it will grow. To the extent also that it can serve rural industries or decentralized industry it will grow. It is a lusty American infant industry which may serve more rural consumers before it completes its ultimate growth than there are potential rural consumers at present. Engineers are not prophets, but they can read meters, and some of the statistical odometers of industrial progress have started with as slow a rate of acceleration as the early stages of rural electrification.

Before we examine the technology of rural electrification, let us view rural electrification in perspective. A logical approach for engineers may be to view it objectively in a mathematical equation in which the summation of achievement in rural electrification is proportional to social, economic, and technological factors involved during the period of time in question. No direct solution for this equation is proposed. It is offered for your consideration merely to clarify the viewpoint that while rural electrification is inseparably composed of all three factors—social, economic, and technical—it is influenced directly by the value of any one of the three. For example, if any one of the factors were zero, that is, absent, rural electrification would be nonexistent.

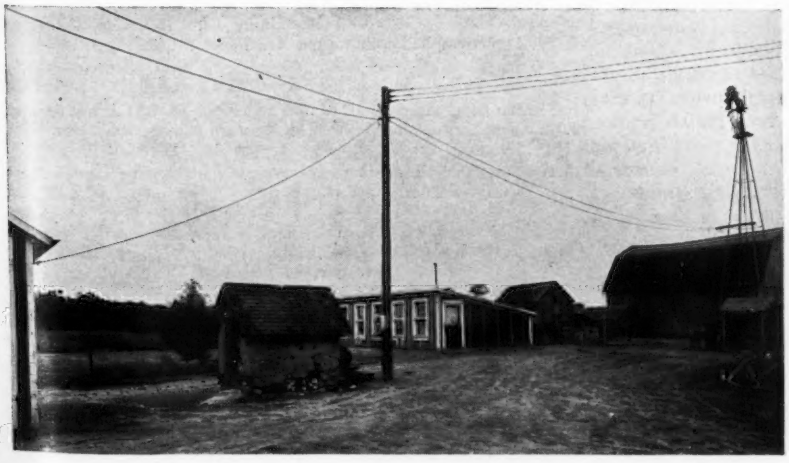
The social aspects of this equation involve people and organizations used by them to accomplish rural electrification, including among others the use of organizations such as corporations, stock exchanges, government—legislative, administrative, and judicial — farmers' cooperatives, and others. What the social factor contributes to rural electrification is indispensable, and the contribution of some persons here is important in this field. But social development is not technology and not engineering, and there are many more people engaged in developing the various social aspects of rural electrification than are available to develop its essential technology.

The economic aspects of this equation involve financing, including capital, its procurement, use, and returns to private investors, corporations, government, manufacturers, utilities, dealers, cooperatives, farmers, and others. It deals in stocks, bonds, interest, taxes, disbursements for operations, collections for service and interest, and profits. It is a spontaneously growing factor if profits are attractive to investors. It will grow on a cost basis if profits or equivalent satisfactions are yielded to consumers. As with the social factor, far more people have been dealing with the economic factor than are available for promoting progress in the unique technology of rural electrification.

The technological aspects of the equation involve innovation, efficiency, and salability in the distribution and use of electric energy and homes, on farms, and in rural industries.

The progress of technology in rural electrification needs not to be recounted to agricultural engineers. It has developed approximately three hundred adaptations or new uses for electricity specifically for rural need. It has lowered the cost of rural service line construction and energy distribution. It has used the principle of self-help where otherwise lines or installations would have been unattainable. Its exponents have the rugged assurance of pioneers extending a frontier. A frontier of a new rural industry, yes, and even more—a frontier of a new way of living for farm people and a frontier of a new agriculture.

A paper presented before a meeting of the Southern section of the American Society of Agricultural Engineers at Atlanta, Ga., February 7, 1941. Author: In charge of agricultural engineering and home economics section, Extension Service, U. S. Department of Agriculture.



Progress in rural electrification depends on parallel development of its social, economic and technical factors. The technical factor, of which agricultural engineering is an important part, must progress rapidly to keep up with progress in the other factors

The pioneers, however, are not all technologists. Some have set the pace in the social and the economic work that has advanced rural electrification. Neither are the technologists all agricultural engineers, nor even all engineers. Some are home economists, and some are physicists, or chemists, or experimental scientists of various biological classifications. The pioneers are the people who best understand rural electrification as a frontier development, and who have enthusiasm in spite of the odds. Their ingenuity and persistence has brought electricity to over two million farms.

In this perspective view it is only appropriate to observe that there have been divergent elements in both the social and the economic factors, but in the technological field the physical evidences of progress have been most readily demonstrated as they are developed. Engineers are the principal contributors to technology. They are far less in number than the persons engaged in the social and economic features of rural electrification. They have only one direction of progress to consider as useful to society and the consumer, and that is continually to improve the value of electric service in agricultural and rural living. The number of persons devoting their time to this objective exclusively is only a minor fraction of the membership of the American Society of Agricultural Engineers, plus probably a smaller number of electrical engineers.

Progress in rural electrification is growing by leaps and bounds, but inevitably the technological factor must be increased or the growth of rural electrification will be checked. Even if the number of rural consumers could be increased without commensurate technological progress, the best values in rural use of electrical energy would be retarded or limited in development.

TECHNICAL PROGRESS DEPENDS ON RESEARCH

To summarize our perspective, rural electrification is now growing rapidly and is receiving increasing social and economic impetus, but is in need of further acceleration of rural electrification technology to keep pace with the expansion of service in farming areas presenting new problems in the use of electricity. There are too few technologists of the various kinds needed to deal with this phase of the work. Primarily their job is technological and not social or economic. Even low-income adaptations should be explored as innovations first, with efficiency and salability as considerations for refinement. Inventive progress has most frequently flouted the counsel of established practice, at least in experimentation.

Since only part of such investigations may yield early economic results, it might well be the objective of the Rural Electric Division of the A.S.A.E. to bend every effort to support successful rural electrification through encouraging the necessary breadth and intensity of research to explore independently, technological frontiers and economic adaptations. The present trend in economic usage investigations is important and should be spread to an even greater number of types of farms, but it is like a fire engine pumping from a tub. Greater capacity in the research reservoir is needed. Engineers need to revitalize and unify their technological contribution to rural electrification. Is that not their place in the perspective view of the rural electrification program?

And what meaning has this proposal for extension workers concerned with the best use of electricity in rural America? I will answer this with another question. What will such research mean to farm people in every advantage that is dependent on electrification? Engineers have the vision to furnish that answer. Let us concentrate engineering efforts on solving the problems in technological progress as one of the three essentials of the tripod foundation of rural electrification.

Aids to Judgment in Irrigation

(Continued from page 131)

United States east of the 100th meridian, with the exception of the southern part of Florida, is intended to include an evaluation of both short intense droughts and long, less intense ones, and is based on the assumed standard that one inch of water in 10 days is the basic crop requirement. When less than that amount is received, a net water deficit is considered to exist. The season's total of daily deficits for each locality is evaluated, and from the season's totals, the average seasonal deficit. The method of doing this is discussed in a previous paper[10].

The average seasonal irrigation need for each locality was plotted on a base map and then lines of equal irrigation need drawn in exactly as contour lines on a contour map, or isobars or isotherms on a weather map. We believe, as far as rainfall is concerned, that this map (Fig. 1) shows relative irrigation need of the different parts of the area considered on the basis used—one inch in 10 days. While we prefer to think of it as showing the relative irrigation needs of the different localities, we hope that it shows, at least approximately, the depth in irrigation water that would have to be made available to plant roots to maintain a moisture supply on the basis noted.

We are of the opinion that a locality showing an irrigation need of 5.0 needs irrigation twice as much as one with an irrigation need of 2.5. At just what point it becomes profitable to irrigate we are not prepared to say.

The preparation of this map was started by me, while a member of the division of drainage of the Bureau of Agricultural Engineering and completed by James Turnbull, Jr., civil engineer, division of drainage, Soil Conservation Service. It is based on data compiled by that division, in cooperation with the Weather Bureau and the Works Progress Administration.

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Harvesting Grain Sorghums

By F. C. Fenton
FELLOW A.S.A.E.

SORGHUMS have been grown both as a grain crop and for forage in the Southwest for many years. In recent years they have spread rapidly eastward and northward into Nebraska and South Dakota, displacing the corn crop in the farming program. The 1940 crop of grain sorghums has been estimated at 150,000,000 bushels.

The change from corn to sorghums seems to be a wise one for the western farmers. Corn has been a very uncertain crop, particularly during the past eight years. Sorghums are more drought-resistant than corn; they do not burn up during a few weeks of hot weather, but rather they stop growing, curl their leaves, and wait for a rain. When rains come, they resume their growth and are little damaged by the dry period.

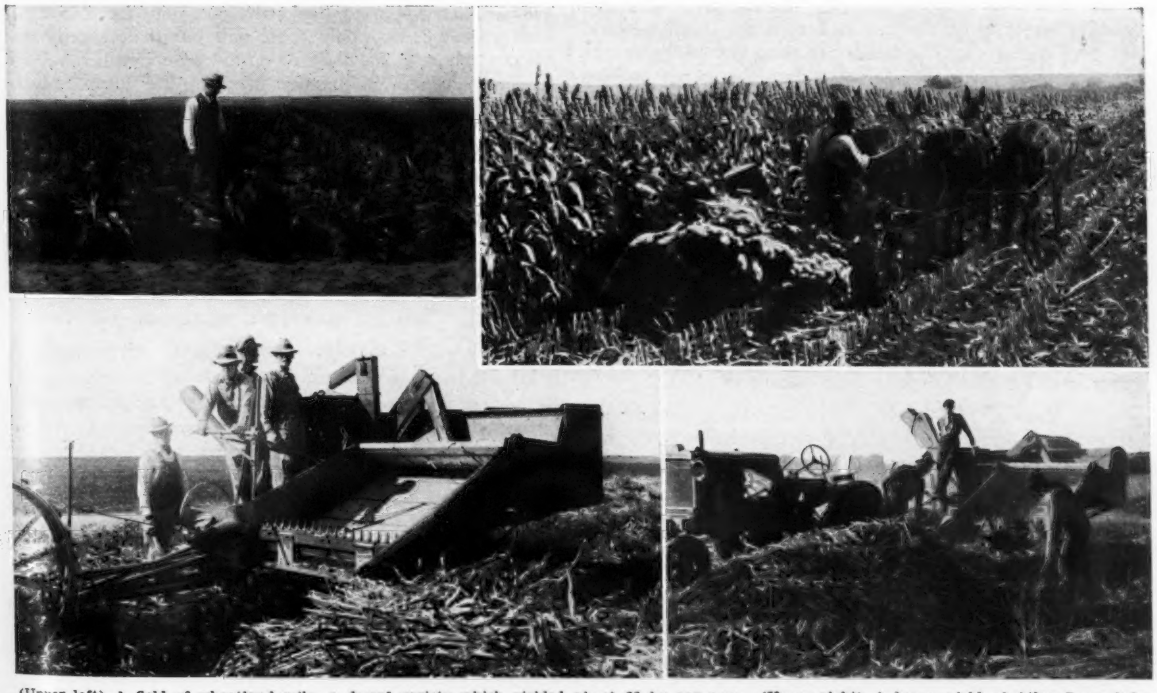
Grain sorghum fits well into the farming program of the wheat growing regions, providing another cash crop for use on land on which the wheat has winter killed. It provides an excellent feed for livestock which compares favorably with corn when used either as grain or forage. Analyses of corn and kafir show that the two grains are almost identical in total carbohydrates. Kafir is slightly higher in protein than corn, while corn is higher in fat. Comparative feeding trials show comparable gains.

Sorghums provide excellent protection against soil blowing during the winter and spring months. When harvested with a combine in the fall, most of the stover is left on the ground to furnish protection from the wind. In some of the western areas most subject to wind erosion, the seeding of alternate strips of wheat and sorghum, 100 to 200 ft wide, has eliminated all soil blowing.

Sorghum Types. Sorghums may be divided roughly into two types, grain sorghums and forage sorghums, depending upon the main objective in growing the crop. The types grown primarily for forage, of which Atlas Sorgo is a good example, are tall and heavy, producing crops yielding 12 to 15 tons of silage on good land. Another variety, Blackhull Kafir, is a combination grain and forage crop, growing to a moderate height and producing a fine crop of grain as well as forage. The more recent development is the dwarf type of grain sorghum grown primarily for grain. These varieties grow to a height of 30 to 40 in, holding their heads well above the leaves and having stiff stalks to withstand lodging during the fall winds. The Kafirs and milos are the most important of the grain sorghums. Blackhull Kafir, Red Kafir, Wheatland Milo, Dwarf Yellow Milo, and Sooner Milo are only a few of the many varieties grown in the region.

Grain sorghums are being harvested by hand and by machine methods and with a great variety of equipment. There is probably no other grain crop which can be harvested as easily by so many different methods without loss in the quality of the grain. The sorghum plant produces grain in a head held well above the leaves so that hand or machine methods of harvesting are easily performed.

A paper presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 4, 1940. (Contribution No. 100 of the agricultural engineering department, Kansas State College.) Author: Professor and head of the agricultural engineering department, Kansas State College.



(Upper left) A field of wheatland milo, a dwarf variety which yielded about 60 bu per acre. (Upper right) A heavy yield of Atlas Sorgo being bound for fodder or silage. (Lower left) Heading the bundles of grain sorghum with a small combine. (Lower right) Threshing headed grain sorghum from small piles on the ground

Hand Methods of Harvesting. Hand topping of grain sorghum is a satisfactory method for small acreages. In hand topping, the worker passes through the field between the rows of grain, cutting the heads from the stalk and tossing them into a wagon driven alongside. It is an operation no more laborious nor slower than husking corn by hand. Speed in topping sorghum is seldom attempted as it is in corn husking, probably because there is less reason for haste, because harvesting by hand can be continued through the winter months.

One man can top from one to three acres in a day, depending on the variety, the thickness of the crop, and how well it is standing up. Bainer reported in a survey conducted in 1927 that "fifty per cent of the sorghums grown in the Southwest were hand topped. . . . . Many of the farmers favored this method because of the small field losses and little cash outlay for harvesting." Machine methods of harvesting have increased since 1927 because the combine has become almost universally used for wheat and because the farmer does not favor hand methods where power and machinery are available.

VARIETY OF MECHANICAL HARVESTING METHODS

Binding. A popular and satisfactory method of harvesting both grain and forage sorghums is by binding them with the standard row binder. This is the most practicable method to use with the taller growing varieties which are grown for forage as well as for grain. The bundles are placed in shocks where the grain on the top is exposed for rapid drying. Much of the bound sorghums are fed in the bundle as fodder. Some are ground or chopped before feeding, and a great deal is used to fill silos. The desire for a field ensilage cutter has caused many farmers to design and construct such machines from parts available locally.

The grain can be removed from the bundles in a number of different ways. The "cheese-knife topper" is used to cut the heads, a single stroke being required to sever the heads from one bundle. Another method is to lay the bundles carefully on the hay rack with the heads projecting over the sides. The heads are then cut off by means of a common hay knife which drops the heads on the ground beside the wagon.

A method which is growing in popularity is to cut the heads directly from the bundles with a combine sickle attachment which is turned in an upward direction. The combine is pulled along the row of shocks in the field and each bundle is lifted from the shock and the heads laid across the sickle bar. Two men can work effectively with a small combine in this operation. The heads cut off by the sickle fall on the elevating canvas which takes them into the threshing cylinder. The heads projecting above the bundles in the shock have ample opportunity for drying. In this way sorghum is threshed with little extra labor and the stover is still available for feeding purposes.

The Header. Although a very successful method of harvesting grain sorghums of the dwarf varieties, the use of the header has declined because it has all but passed out of the picture in the wheat harvest. Many old headers discarded by wheat growers have been available and have been used to some extent. The sorghum heads, after being cut, are dropped on the platform canvas and elevated into a "header barge" driven alongside the header. The heads are hauled to the desired place and pitched off onto stacks or piles to dry out before threshing.

Where the crop grows irregular in height, it is necessary to take considerable length of stalk in order to get all of the grain. If the stalk is full of juice when first cut, the heads dry out more slowly than when left standing.

Loss of Grain in Header Operation. Sorghum heads are lost from lodged stalks on which the heads cannot be cut and dropped on the platform canvas, and from heads which are thrown off the platform by the action of the reel. Lodged heads cannot be harvested by machine methods and for this reason the ability of a variety to stand up until harvested is an important point. Plant breeders have done remarkably well in developing dwarf varieties of sorghums with stiff stalks and straight necks which will stand up in the windy weather of the plains. Varieties differ widely in their ability to stand up until harvested, but even the better varieties lodge badly in certain seasons. Sorghums killed by a hard freeze before maturity go down more quickly than when they ripen normally.

Reel Adjustment to Prevent Throwing Heads. Some heads will be thrown away from the platform unless some changes are made in the reel. The reel slats may be widened by the addition of wide pieces of light-weight siding. The wider reel slat prevents the heads from catching on the edge of the slat and being thrown off the platform. A reel properly adjusted will give the sorghum heads a gentle push toward the platform but will have no tendency to pick them up or to throw them. Reels not properly adjusted will sometimes throw as much as 10 per cent of the heads off the platform. These heads can be saved by hand picking the field, but most of the reel loss can be avoided by proper adjustment.

Header and Dump Box. A dump box used with the header has been developed by L. C. Aicher at the Fort Hays station and used successfully for a number of years. This device consists of a dump box drawn along with the header and filled with the headed grain. When the box is filled, the contents are dumped on the ground in a pile to dry out before threshing. This operation saves the labor of hauling and stacking the heads. The heads are dumped in a loose pile in which they dry out rapidly provided weather conditions are favorable. The seasons have been generally favorable in this area since the dump box has been used, but no doubt there will be an occasional year when sorghum heads dumped on the ground will mold and spoil in considerable quantity. In using the dump box, the piles are placed in windrows for ease in threshing. The combine is pulled along a row of these piles and the heads pitched onto the platform canvas.

The Combine-Harvester for Harvesting Grain Sorghums. Because the combine is used so extensively for wheat in this area, it is desirable to use it for harvesting grain sorghums. It is being used more and more and will probably continue to be used wherever sorghums are grown.

SPECIAL HANDLING PROBLEMS

Problem of Lodged or Down Grain. All varieties of grain sorghums tend to go down or lodge in strong winds after heavy freezes have killed the plant. The seasons differ in the extent and amount of lodged grain, but it is evident that even the better varieties, during some seasons, will have a rather large percentage of the grain down on the ground where the combine cannot reach it.

In order to avoid the losses due to lodged grain, the tendency is to begin combining before the grain is dry enough for safe storage. Here again it is a matter of the season. In some seasons the grain may be dry enough when combined to keep safely, but records show that in about half of the seasons the grain will contain an excess of moisture and must be handled so that it will not spoil.

Combining of grain sorghums is complicated by the uneven ripening of the crop. *(Continued on page 142)*

Controlled Drainage

By David H. Harker
MEMBER A.S.A.E.

TO some, controlled drainage may be an unfamiliar phase of soil and water conservation. For others it may be necessary to define terms, because you may have in mind the same practice by another name. And for still others it may be necessary to draw a fine line of distinction between controlled drainage and subirrigation. There is a difference.

Although some attention may have been given earlier to drainage control in other parts of the United States, in the Midwest it is a recent practice. My first interest in controlled drainage was aroused in the dry summer of 1936. One of our farmers in Laporte County, Indiana, conceived the notion of placing dams in his open ditches in order to provide moisture for his crops, principally corn. Now control is employed more in connection with muck land, but I can conceive of all drainage being controlled in years to come. It cannot be until systems of maintenance have been developed to the point where the required structures are assured proper operation and maintenance.

During the same summer many inquiries came to the extension department at Purdue University in regard to what might be done in time of drought to provide moisture, on muck lands particularly. Vegetable crops grow relatively shallow roots and need a high water table. Vegetable crops on muck soil are, therefore, in constant danger of moisture shortage because the water table in muck land flattens out when the rainfall is deficient. Since these are high-income crops, they will support the cost of controlled drainage. In fact, since they are costly crops to produce, the muck farm operator cannot afford to risk failure from the standpoint of moisture shortage. We began inquiries into what had been done, and found that there was nothing available in written form upon the subject, although individuals in neighboring states had tried out certain drainage control practices. Then, to our surprise, we began finding that some Indiana muck crop growers had been practicing control to some extent. It was the operators of the larger muck crop farms who had tried and proven control, not only because they had the funds but also because the extent of their holdings made it easier of accomplishment.

A paper presented before the Soil and Water Conservation Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 6, 1940. Author: Drainage extension specialist, Purdue University.

By the same token, it was the smaller muck crop operators who sought information and assistance. Their problem is more difficult because they find it nearly impossible to build expensive structures, and what is worse, the small grower usually has so small an acreage that, without the cooperation of neighbors, he cannot practice control. That is, control drainage must be practiced rather generally throughout the entire watershed of a headwater stream to realize maximum effectiveness at minimum expense. Quite often the operator of the larger muck crop farm either already owns a sufficient acreage or can acquire it. Then the construction of dams totaling a thousand dollars may benefit hundreds of acres, and the project becomes economically feasible.

Do state laws permit the construction of dams in public ditches? In many states where public drains are operated and maintained by drainage district organizations, dams might be installed and operated by the district, if such practice is found to be to the best interest of the farmers of the district. In Indiana we have no drainage district law. Consequently, when a group of farmers decide to undertake the construction of dams for control of a public ditch, they must petition the court for the establishing of such control. This lays the project wide open to remonstrators, of which there are always a few. We have had several groups of farmers entertaining the idea of control, but the chance of taking it past the remonstrance has looked too slight, and to my knowledge, no public ditch has been set up for controlled drainage in Indiana by due process of law.

In the Midwest, because of the excessive rainfall in the late winter and early spring months, we normally come to the time for spring cultivation and planting with the hydrostatic water table too high. It is then necessary for us to construct open and tile drains to lower the water table artificially. The importance of drainage lies not alone in making early cultivation possible, but also in providing a root zone deep enough that crops can put down ample root systems.

We are agreed, I am sure, that drainage in the spring is a definite need. But effective drainage is seldom obtained for wide expanses by open ditches shallower than 4 ft. More often our headwater ditches must be 5 or 6 ft deep and our

(Left) Beebe dam at Niles, Mich., constructed of ⅝-in sheet steel, the man indicating the elevation at which the water is maintained during the summer. (Right) Gehring dam, near Newland, Ind., built of 10-gage corrugated sheet steel piling, with pumping arrangements to take water to or away from his muck crop land as needed

main outlet channels are 8 or 10 ft deep, sometimes much deeper. We are often criticized, by those who do not understand the need, for constructing our open channels too deep. Those of us who work constantly with land drainage, know that to furnish adequate outlet for lands lying back away from the ditch, deep ditches are sometimes unavoidable.

Then we all recognize the likewise obvious fact that sometimes these very ditches, sorely needed in the springtime in order that the farmer might get his crop started, cause a gradual lowering of the water table throughout the summer. If there is a marked deficiency in rainfall, the water table may drop so low that even the deeped-rooted crops reach moisture with extreme difficulty. The result under such circumstances is a tendency for crops to wilt and wither or, as in the case of corn, to dry up in late August without proper finish or maturity.

It is the realization that, while we need drainage in the spring, we need moisture throughout the summer, which has brought us to the consideration of what we call controlled drainage. It is exactly what the name implies, the control or regulation of the taking away, or drainage, of hydrostatic water from the soil. For while we need the water table lowered in the spring, we also need it maintained at a reasonble level in the ensuing months. So, toward the end of the spring rains we want some provisions for holding back the water in the soil by holding it in the drainage systems.

CONTROLLED DRAINAGE DISTINGUISHED FROM SUBIRRIGATION

Here is the distinction between subirrigation and controlled drainage. In subirrigation we attempt to raise the water table, when it has fallen low, or at least to supply moisture at the roots of the crop for a period of time; but in controlled drainage we attempt to take off only that amount of soil water which is detrimental, keeping the water table always as high as is possible for the good of the crops. Subirrigation is accomplished with ditches laid either level or with fall from the source of water supply to the soil to be irrigated; but controlled drainage is accomplished by the regular gravity drainage system in which dams have been placed for seasonal use. Finally, subirrigation is accomplished by adding water from an outside source; controlled drainage is accomplished by retaining as much of the soil water as possible and by collecting and holding other water which may come to it by percolation.

Control therefore depends upon our being ready in the spring with structures which can be closed to hold back the water in the ditches, and finally in the soil. With a wide-open, unimpeded drainage system through the winter and into May, the excess water is taken out and the crops are started. In May the process of building up the water table will begin by the partial closing of structures. By June the heaviest of the spring rains usually are past and the water table is as high as our particular crop will tolerate. Through July and August, with normal precipitation, the water table drops a little because of evaporation and crop use. Or, if the summer has been very dry, the water table may have fallen considerably, but the effect of the retention of whatever amount of moisture falls in the late spring is even more telling because it is more seriously needed. In September the crop is made and the dams are again opened up to allow for the passing of floodwaters throughout the winter.

To look at some actual cases, a Laporte County farmer had the right idea, but he had it too late. When his corn was burning up in August 1936, he built a dam and began impounding water in a 9-ft public open ditch. There was a fair flow of water in the channel, but it required 4 days to raise the water to an 8-ft depth behind the earth dam. This farmer wanted to know how he was affecting the water table back away from the ditch. So he dug post holes at intervals of 100 ft back from the ditch a distance of 600 ft. He kept no records but simply observed the effect of his efforts. Undoubtedly, the water table was quite low before the undertaking because the corn had begun to dry up. It was determined that it required 10 days for the water to find the same level in the soil at 600 ft from the ditch as in the ditch itself. As would be expected, the water table in the soil lagged the impounded level. Given sufficient time, this man would have saved his crop. He did help it. But the earth dam he had constructed so hurriedly borke after about 10 days and the water table dropped, returning to its former low level.

At the Clyde Beebe farm at Niles, Mich., three sheet-steel dams have been in use for many years. We walked through the mint fields beside the bank-full open ditches in August 1936, when the water table was high enough that the water oozed up in our foot tracks. That year the Beebe mint crop produced 80 lb of mint oil per acre while on other farms in the vicinity production was as low as 20 or 30 lb. In some years these dams on the Beebe farm are not seriously needed, but in the years when they are needed they are ready to serve; and they are used to some extent every year.

DRAINAGE EXPERIENCE LEADS TO DESIRE FOR CONTROL

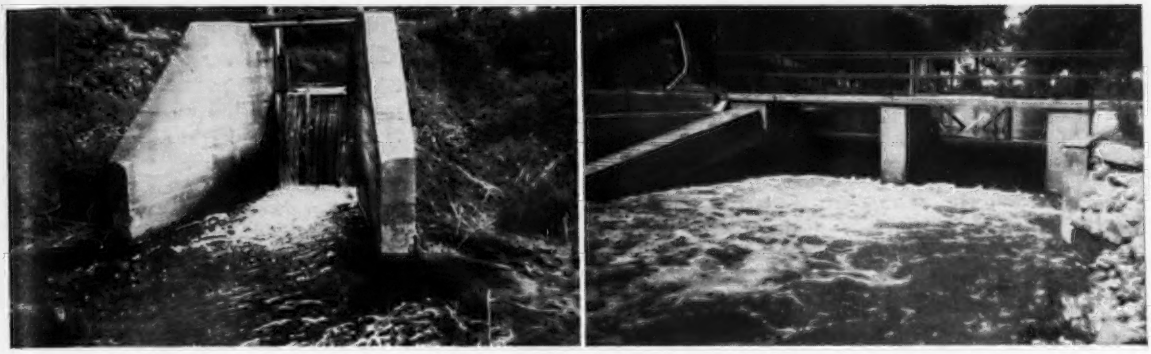
A few years ago the manager of the Scholl farm in Laporte County, Indiana, asked for advice regarding drainage of some new muck in the valley of the Little Kankakee. There are about 100 acres in the valley which belong to the farm, all extremely flat and sloping slightly toward the stream and with its flow. We advised a system of open ditches supplemented by tile but cautioned against their cutting the channels too deep. We suggested at the time that, if there was any thought of truck crops, they might eventually want to install control structures. At the time they thought not.

The ditches were constructed much deeper than was recommended and common farm crops were grown for a year or two. Last year a truck gardner was hired to manage the farm, and in spite of the lowered water table he made a success of growing onions. This spring we helped him plan control structures, one of which has been installed.

In the summer of 1936, while holding a meeting with truck growers in Pulaski County, Indiana, we learned that Gumz Brothers of North Judson had been practicing control on farms aggregating hundreds of acres of muck crops. They used structures not only in their open drains, but also in their tile lines. Since that time we have advised with them in the construction of new concrete dams.

An interesting case is the one of Robert Craigmile whose farm adjoins Bass Lake on the west, south of Knox, Indiana. His muck land lies so low that he must pump in the spring of the year to drain the soil for truck planting. This pumping continues until the water table normally becomes low enough to obviate the pumping. Seepage back from the lake always keeps his water table high enough for his special crops.

A like case is the one of William Gehring at Newland, Indiana. Three years ago Mr. Gehring asked our advice about the design for dams in some new open ditches which he had constructed to drain three hundred acres of new muck. He constructed one large dam and grew three hundred acres of potatoes with unusual success. He found that his control system was entirely adequate for retaining moisture through the summer but that he needed more underdrainage to remove the excess water at times, principally in



(Left) Todd dam near Mentha, Mich., controlling an intensive system with the help of a second dam and numerous stopwells in the tile mains. (Right) Dam at North Liberty, Ind., serving to create a pool in the city park, to maintain the water level in the fish ponds of the conservation club, and to bolster the water table for farmers in dry summers

the spring. Last year we helped him lay out a system of tile mains and laterals with stop wells for control. He immediately installed the mains and this year he has had signal success in growing onions on the same 300 acres in spite of the July and August drought. As in the aforementioned case, Gehring has so arranged his control that he can pump either way—out in the spring and back to his private ditches during the summer.

While, to my knowledge, in Indiana we have had no difficulty with the silting up of tile systems under control, it is said that in certain experiments conducted in Florida muck fields, tile underdrainage was not so successful. Not only did the tile lines silt up, but it was nearly impossible to keep the tile on grade due to subsidence of the muck soil. On these experiments mole drainage was finally tried and proved quite successful.

Michigan farms especially have gone far in the matter of controlled drainage. One in particular has had a system of control for ten years or more. This case is particularly interesting in the manner of its development. The manager told us that when the operators acquired the land years ago, there had been no outlet drainage provided for the valley and that a very inadequate natural stream eventually carried off the excess water. This natural drainage was so delayed he related, that planting was often held up to a considerable extent.

Then the landowners downstream, growing common farm crops petitioned the court for the construction of an outlet drain. The petitioned was granted and the open channel was brought up to and through the muck crops farm under discussion. The muck farm operators then installed systems of tile to drain the hundred of acres of muck for truck crops. The outlet drain and the tile systems served to improve crops for several years until much of the humus was farmed out of the top soil. Finally the soil began to show signs of becoming droughty. The manager said that their first attempt to counteract this was the construction of dams in their open channel, which was successful alone for a few years. Then it became apparent that further control was needed, so they decided to control the flow in the tile systems. However, these systems had not been constructed for control, but for drainage only. They were not regular and frequent enough to do the job uniformly.

Here the last phase of this development began. The tile systems were relaid in regular patterns with control boxes, or stop wells, at points where needed. But, according to the manager, they felt that they observed the crops suffering to some extent from a toxic condition which they believed to be generated by the water's standing unchanged in the subsoil. So they set about to remedy that situation also. At one tile source there were several flowing wells. The water from these wells was directed into the tile head to contribute fresh water. A quarter of a mile away from another tile source was a small creek in an adjacent watershed. By building a dam and a diversion ditch from the creek to the tile head it was possible almost all summer long to add fresh water at this point. Consequently, the details of control were so arranged that the soil water can now be drained away, retained or replaced by fresh water as circumstances require. The manager told us that their control is delicate enough that by removing or replacing crestboards in stop wells, it is possible to lower or raise the water table overnight in almost any ten-acre plot to accommodate their schedule of farming operations.

What does it take to establish such control? First and foremost, let us recognize that adequate outlet drainage is required. It is the height of folly to try to establish control in drainage systems which, to begin with, are inadequate to carry away floodwaters and to reduce the water table to the lowest level needed in any eventuality. Open channels must be deep enough and of sufficient capacity. Control structures are next in importance, dams in the open channels and stop wells in the tile systems. If a supply of fresh water is available from any source, it is unquestionably desirable. It may or may not be essential from the standpoint of keeping down the toxic condition in the subsoil, but it is useful in helping to maintain the water table.

Of adequate outlet, there need be no discussion. Of control dam construction much can be said. Such structures must have ample floodway, sufficient to pass the maximum discharge of the open channel without undesirable backwater effects. The control dam must go well into the banks and well below the channel bottom to prevent serious seepage, not because of water losses, but because of danger of damage to the structure. The dam must have lateral stability to withstand the water pressure. There must be a paved spillway to prevent undercutting of the structure.

For the actual gate control, there is no better solution than crest boards. The boards can be taken off the top and replaced easily, giving a fixed crest at any desired elevation. Certain farmers have tried bulkheads, or gates, raised vertically by windlass, but invariably, to our knowledge, with sad experience. Such gates require considerable power for operation and they require almost constant attention and adjusting to maintain a desired water table level.

The stopwell is a simple structure, consisting simply of a concrete box about 3 ft square, inside dimensions, as deep as depth of the tile line. Or, the well may be 18 to 24 in deeper than the outlet tile if a catch basin for silt is desired.

In the sidewalls of the well, 2-in wide grooves are formed from the bottom to the top. Planks can then be dropped into the grooves to form a dam crest. The 3-ft square horizontal cross section allows room for a workman to repair the stopwell or to clean the catch basin.

There are many things we need to know about control and about the required structures. For example, in order to establish control more intelligently, we need to know how various soils can be expected to react to control and how the soil profile will affect the maintenance of the water table; for while at the present time the chief interest in control comes from muck land farmers, we believe that the principles of control can and will be applied to drainage systems in general.

DRAINAGE CONTROL LIMITED BY SOIL

A farmer recently asked us if we would recommend controlled drainage practices for his stream valley where the soil was but 3 ft deep, underlaid with 2 ft of gravel, resting immediately upon faulty bed rock. Obviously his valley has perfect natural drainage and all the dams and stopwells he could build would not keep the water from getting away below. We advised him against it. Soil profile must be considered.

About the structures, we need to know particularly how far into the banks and how deep below stream bed the dams need to go to discourage seepage effectively. Opinion varies greatly, especially in regard to depth. One engineering office insisted on sheet piling driven 20 ft below stream bed to maintain a six-foot head of water. Certain theories from the Harvard engineering school tend to show that a depth equal to the head of water is sufficient.

Again, we need to know what material will provide the cheapest and best dams. Regular ⅝-in sheet steel piling undoubtedly makes as good a dam as can be had, but it requires a mechanical means of driving and the material is costly. Corrugated sheet steel piling can be driven more easily, but has insufficient lateral support of itself, cannot be expected to last indefinitely, and is rather expensive. Wooden structures are cheap enough but not durable enough. Earth dams when built properly require considerable embankment and a conduit with concrete intake and outfall.

It would seem that, in general, a concrete structure with crestboards and a piling cutoff wall may be the cheapest and best when durability is considered. For low dams in small streams, wooden or corrugated sheet steel may best be used. If such small structures must be replaced more frequently, at least the cost is not great.

There are several real advantages to controlled drainage, aside from providing moisture for crops. One of the greatest annual losses in muck regions comes from muck fires where the soil dries out to great depths. Fires in this high humus soil are much more easily controlled and extinguished, because of the higher water table where drainage is under control. Likewise, the capillary rise from a water table close to the surface keeps the soil moist and discourages wind erosion. Even with control, green or golden willow windbreaks are advisable. Again, many muck crop growers with systems of controlled drainage report that crops on land so controlled are less subject to damage from light early frosts.

If this discussion serves to arouse interest in controlled drainage, and perhaps some attempts to obtain information by research, it will have accomplished its purpose. We realize that there is more to be learned than is already known upon the subject. What has been stated here is our opinion, based upon observation of the practices of control which have come under our notice.

Harvesting Grain Sorghums

(Continued from page 138)

The heads mature while the leaves and stalks are still green and filled with juice. Even when the heads are mature and dry, some moisture may be added to the grain by the juice in the stalks which are crushed and broken in the threshing process.

Threshing of Grain Sorghums. Most varieties of grain sorghums thresh out of the head very easily when they are dry. Generally one concave is all that is necessary to get complete removal of the grain from the head. Good threshing depends on the kind and the condition of the grain, and machine adjustments must be made to suit conditions. Grain sorghums crack easily. The drier they are, the more easily they crack in threshing, but it is possible by proper machine adjustments to reduce the amount of cracked grain to 5 per cent or less.

The cylinder speed should be reduced to two-thirds or three-fourths of the rated speed of the machine for threshing wheat. Since the speed of the other parts of the separator should remain the same, the speed changes should be made by a change of pulleys or sprockets driving the machine, larger for the main cylinder drive and larger from the driving pulley to the remaining machine. Special sprockets or pulleys are available for most machines, but farmers either do not know about these changes or do not take the trouble to make the change. Newer combines have made provision for these changes by adjustable V-belt pulleys.

Both the angle bar and the rasp bar types of cylinder have given good results in threshing sorghums. It is the observation of the author that these types crack less grain under most conditions if properly adjusted than the tooth cylinder and concave. However, combines having the rasp bar type of cylinder will crack a large part of the grain if set too close and run at high speed.

Special screens and sieves are not usually used since the modern machines are equipped with adjustable sieves and chaffers. Straw racks and walkers sometimes clog up with the stiff stalks and especially close observation must be maintained by the operator.

Under certain conditions of threshing, particularly when stalks are frozen, the pithy stalk centers will tend to circulate through the machine by being repeatedly reelevated by the tailings elevator. This material being returned to the cylinder a sufficient number of times, will be chopped fine enough to go through with the grain. This pithy material is high in moisture content and will raise the moisture content of the grain. This can be prevented by placing a sheet metal covering over the tailings trough without any appreciable loss of grain, because sorghums do not need rethreshing to take out all of the grain.

Cracking. High cylinder speeds and too close adjustment of the concave are the main causes of excessive cracking of the grain. From the standpoint of feed for livestock, cracked grain is not objectionable; in fact, all sorghum should be cracked before feeding. From a market standpoint, only a moderate amount of cracked grain is permitted without loss in grade and lower price. From the storage standpoint, cracked grain gains moisture more rapidly than the whole grain. Cracked grain also tends to prevent free air circulation in stored grain and may be a contributing cause of trouble due to heating and molding.

Because of the trouble often encountered in storing sorghum grains, a method of harvesting should be followed which will result in grain dry enough to store safely. The use of the combine, while desirable from the labor-saving standpoint, will create a storage problem in certain seasons.

Some Development Trends in the Farm Freezing and Storing of Food

By Geo. W. Kable
FELLOW A.S.A.E.

FREEZING of food products and their storage in frozen condition is no longer a novelty, either commercially or on the farm. What we, as agricultural engineers, are interested in is the trend which the development will take. It is not a question of whether food products can be frozen and stored on the farm, but how will this be done and what types of equipment will best answer the needs.

Frozen fruits put up in barrel packs have been used by bakers, jam makers, and hotels for many years. Fish have also been handled in large quantities in frozen condition. It is only within the past decade, however, that retail sales of frozen products have become common. At present, there are few cities of any size which do not sell frozen meats, fruits, and vegetables in family-sized packages at local grocery or produce stores.

On July 1, 1940, there were in the United States 2,838 locker storage plants serving 743,620 families. By January 1, 1941, this number will have increased to approximately 3,200 plants, the rate of increase being about two locker plants per day.

As an example of the acceptance of food freezing and frozen storage by farmers, the increase in locker plants in Minnesota is interesting. The first plant was installed in 1935. Four were built that year. On July 1, 1940, there were 320 locker storage plants in the state. A report issued by the University of Minnesota early in 1940 stated that 17 per cent of the locker users were city people, leaving 83 per cent of the lockers used by patrons from rural districts.

That freezing and storing of food products is a matter of farm concern is further evidenced by the research work being done by the U. S. Department of Agriculture and the state agricultural experiment stations. At least one state (Washington State College) has issued a publication on the building of homemade farm freezing and storage boxes. Extension agents in the states are becoming increasingly active in the establishment of locker storages and home freezing plants. Two periodical publications are being devoted entirely to the subject of frozen foods. A new one is "The Locker Patron" of Des Moines, Iowa. "Quick Frozen Foods" is a trade publication now in its fourth year. Most farm papers are devoting an increasing amount of space to instructions on varieties that freeze best, methods of preparation for freezing and storage, and how to prepare frozen foods for use.

From such imposing figures and facts, there seems to be little question about the acceptance of frozen food products, either by the city purchaser or the farm user.

A question which might fairly be asked is: Can farmers use this freezing process as successfully as other methods of food preservation? The experience of investigators on food processing seems to indicate that the preparation of foods for freezing is simpler than for canning, and involves less labor. There apparently is no good reason why farmers cannot preserve products by freezing just as successfully as by canning, or that they cannot do the job equally as well as a processor employed by a locker storage plant. There is some question whether they will do it as well, at least in their first attempt.

In this connection, it is important that enthusiasm over the freezing process should not result in overselling it to farm people. Freezing definitely does not improve fruits and vegetables over their fresh condition. Furthermore, attention must be given to the growing of proper varieties, harvesting at the right stage of maturity, and freezing quickly after harvesting, if the best results are to be obtained.

The best answer to the question of farm freezing is that farmers are doing it and have been for several years, and like it. Not all of the farm-frozen products are as good as those which have been grown, harvested, and frozen under expert commercial supervision, but in most cases frozen farm products have been much more acceptable than the same products canned.

The process of preparing and freezing food products at home is practically identical with that of locker storage plants, so the research work which has been done is applicable to both.

There has been a wide variety of storage temperatures in farm plants. I have seen beef, butter, game, fur coats, and other farm products stored with reasonable success in walk-in boxes in Texas cross-roads stores and on large ranches at temperatures of 20 to 30 F (degrees Fahrenheit). The recommended temperatures for satisfactory freezing and storage are, however, quite generally accepted at present as follows:

A paper presented before the Rural Electric Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 5, 1940. Author: Editor, "Electricity on the Farm."

FROZEN FOOD TEMPERATURE RECOMMENDATIONS

Chill (meats)		32 to 34 F
Age (meats)	Relative humidity, 85-90 per cent	36 to 38 F
Freeze		−10 F (range −10 to +10 F)
Store		Zero F (range zero to 17 F)

Most bacteria and yeasts are rendered inactive at temperatures just below 32 F, but chemical activity continues at all temperatures, becoming progressively less as the temperature is lowered. Meats, poultry and fish particularly, should be frozen quickly to prevent dehydration and formation of large ice crystals which tend to rupture the cells and cause excessive leakage on thawing. Quick freezing is not dependent, however, on low temperatures alone. Tressler and DuBois[1] report "a package of meat will freeze more quickly in a zero F air blast than it will at −25 F without the air blast." When storage temperatures are much above zero F, fruits and vegetables slowly lose their bright color, fine flavor and vitamin C content, and fruits darken from oxidation. Meat fats become rancid in 4 to 5 months when stored at 10 F and in 2 to 3 months at 15 F, but keep well for a year at zero F.

It is important that storage temperatures be held as nearly uniform as possible to preserve cell structure. It should be noted also that the lower the freezing and storage temperatures, even below −10 F and zero F, respectively, the better the products. Correct temperatures, therefore, become a matter of economic balance between quality of product and cost of storage.

CHARACTER OF FUTURE QUANTITY DEMAND UNDETERMINED

Development of Farm Equipment. In the development of farm freezing and storage equipment, the engineer has the advantage of knowing rather definitely from the food chemist what the temperature requirements for satisfactory operation are, namely, a freezing compartment with a temperature of −10 F and a storage compartment held at zero F. In addition to the temperature requirements, the freezing compartment should be adequate in size for free circulation of air about the freezing products. To make it still more effective, a simple method of forced-air circulation should be provided.

There is one other requirement which cannot be ignored, particularly where meat, especially beef, is to be frozen. Animals butchered at home must be cooled out before they are cut up for processing. This calls for temporary storage at a point near freezing. In the case of beef, it is also desirable to hold the carcass at a temperature between 32 and 40 F for aging, which develops tenderness. Recent research indicates that proper freezing also develops tenderness in meats. On most farms beef cooling would offer no particular problem, as not more than one or two animals would be butchered per year, and these might be killed during the fall and winter months. In the South, however, and on farms where more beef is killed, this would call for a separate, rather large compartment held at usual refrigerator temperatures and which might also be used for general farm refrigeration.

The question of the most acceptable sizes of farm freezing and storage plants has not been settled. One large manufacturer is just announcing two-temperature domestic boxes, in which space is provided for storage of about 60 lb of frozen products. Another manufacturer is placing his bet on a 4½-cu ft single-temperature freezing box to be used as a supplement to locker storage. At the moment, perhaps the most popular size of two-temperature freezing and storage box designed especially for the farm is from 15 to 30 cu ft, and is a chest model with top-opening lids.

In June 1939[2] H. W. Sterling of the Eastern Shore Public Service Co., Salisbury, Md., made an estimate of the frozen food requirements for a family of four. Based upon a succession of products being put in and taken out, he arrived at a capacity of 35 cu ft. Recently Mr. Sterling has designed a new farm freezing and storage cabinet with a capacity of 56 cu ft. Incidentally, this is a completely homemade cabinet insulated with 12 in of ground cork and cooled by a ¼-hp compressor unit. Mr. Sterling estimates that all materials required for constructing this box, including the compressor unit, could be purchased for approximately $200. In order to provide an inexpensive means of safeguarding against possible power outages up to 4 or 5 days' duration, he suggests filling ordinary empty coffee cans with a 20 per cent common salt brine and freezing them on the shelves of the cabinet.

At the other end of the freezing and storage scale, H. E. Babcock of Ithaca, N. Y., has been making satisfactory use of a 15-cu ft freezer to supply 10 to 11 people, doing his own freezing of home-butchered beef, pork, a dozen chickens at a time, and fruits and vegetables in season.

While standardization upon one or two or three different sizes would aid in bringing equipment prices down, there seems to be no way to determine what these sizes should be, except through trial and error. It is to be expected that standardization will occur as farmers learn from experience which sizes best fit their physical and financial needs, and manufacturers find which are the most salable models.

Types of freezing and frozen storage equipment and services available at the present time may be classified as follows:

1 Locker plants with killing, cooling, processing, packaging, buying, and selling services.

2 Locker or storage plants without auxiliary services.

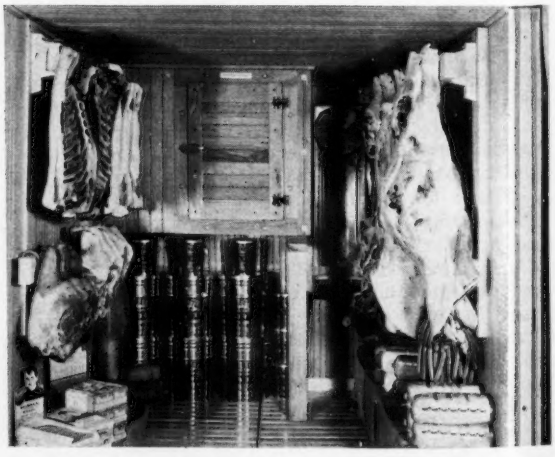
3 Tom-thumb, crossroads locker plant—25 lockers, (White Pine, Tennessee—TVA).

4 Domestic refrigerators with extra large ice-making compartments. (Stewart-Warner, Gibson).

5 Domestic refrigerators with special frozen-storage

[1]Tressler, D. K., and C. W. DuBois. Freezing and storage of foods in freezing cabinets and locker plants. N. Y. State Geneva Sta. Bul. 690 (May 1940).

[2]Sterling, H. W. Advantages of frozen foods to the farmer and the Utility. Rural Electrification Exchange, First Quarter, 1940.



Walk-in refrigerator with a low-temperature compartment, with capacity for a large volume of farm food supplies and storage of perishables before marketing

compartments in addition to ice compartment. (Apex, Continental)

6 Three-temperature domestic and farm refrigerators—34 to 40 F, zero to 10 F, and zero to –18 F. (Continental, Wilson, Esco)

7 Dual-purpose farm boxes of 16 cu ft upward, with 40-F and frozen food compartments. (Chapman, Wilson, Esco)

8 Dual-purpose walk-in farm boxes with large 40-F storage and smaller frozen food compartment. (International Harvester)

9 Single-temperature, frozen-storage cabinets from 4.2 cu ft upward—practically all top opening. (Esco, Victor, Steinhorst, Bussey Pen Products, Wilson, Jewett "Arctic Trunk", Deep-Freeze)

10 Two-temperature cabinets, one for freezing, one for storage. (Esco, Steinhorst, Victor, Wilson)

11 Sharp freezers—8 to 24 cu ft, –5 to –10 F. (Esco)

(There is undoubtedly additional equipment similar to the above made by manufacturers whose products have not come to our attention.)

Lockers vs. Home Freezing. Most manufacturers of home freezing equipment believe that locker plants are here to stay and that home freezers will only supplement locker storage. This is more interesting because it has been expressed by the manufacturers of some of the larger home equipment. The supplemental use may, of course, be of two types—use in connection with locker storage, and use by farmers living at a distance from locker plants or whose requirements are large enough to make home storage more economical. The case for and against lockers may be summarized somewhat as follows:

Lockers require no large investment on the part of the user. He can start with one or two and rent more as needed. Cooling and aging rooms for beef and special quick freezing rooms are provided. Extra services are available, such as slaughtering, meat cutting and wrapping, sausage making, meat sales, and in some places fruit and vegetable preparation. Uniform temperatures are easily maintained. There is little likelihood of spoilage from equipment breakdowns.

In favor of home freezing, products are quickly available when wanted and in emergencies. No large freezing compartment is needed in the home refrigerator for temporary storage of foods from locker. It is always available for freezing small quantities of fruits or vegetables which might otherwise be wasted. Freezing can be done while products are fresh. There is no contamination from adjacent lockers. Farmers will use it more. Locker-plant processing services are usually available to home freezer owners, if wanted.

A survey was made by the University of Minnesota in June 1938[3], in which patrons of 17 Minnesota locker plants expressed their opinions on the advantages and disadvantages of locker storage. Questionnaires were mailed to 3000 users. A few of the opinions expressed are listed in the accompanying table.

It is significant that 214 patrons were interested in eliminating the work of home butchering, processing, and canning. This is in comparison with old methods of curing and preserving. The number giving this reason, in my opinion, would be a small fraction of 214 if the comparison were between locker plant freezing and home freezing. Furthermore, the answers pertain only to meats, not fruits and vegetables.

There are certain facts which should be taken cognizance of, both by engineers and farmers who are interested in home freezing, if the equipment placed on farms is to result in satisfactory service. They are that only varieties suited to freezing should be frozen. Grading and preparation of products should be equal to that of the commercial plant if the products are to be equal. Meat must be properly cooled before freezing. Attention must be given to sanitation to avoid spoilage and off flavors. Proper packaging improves products and their salability.

Manufactured Equipment. A sales agent for one make of refrigerators of 7 to 10-cu ft capacity says, "We feel that the locker plant performs a wonderful service for the farmer, but most farmers seem to resent the service charges of 1½ to 2 cents per pound, which brings the annual locker cost to $25 or $30 instead of the $10 to $12 per year locker rental. Our box is unique in having a total of 6 cu ft freezing and frozen storage out of 10 cu ft total net capacity. Temperatures of the three compartments are 0 to –18, 12 and 40 F."

A new single-compartment, single-temperature, cylinder-shaped chest model freezer has several unusual features. The food barrel is 18 in in diameter and 30 in deep. It contains no refrigerant coils, the freon being circulated through the double-walled steel cylinder which forms the food chamber. It is claimed the cabinet may be held within 2 deg of the refrigerant temperature, resulting in little dehydration of products and frosting of walls, and permitting the unit to work on 8 lb back pressure when holding at zero F. The ¼-hp compressor is reported to consume about ½ kw-hr per day. The cabinet is intended primarily for holding commercially frozen products which may be purchased in institutional sizes at a claimed saving of 40 per cent, and as a supplement to locker storage.

The 6 and 8-cu ft boxes of another make of refrigerator operate through a refrigerant valve which keeps the freezing locker always 30 F below the temperature of the food compartment, which has an adjustable temperature control.

At the opposite range of sizes, another manufacturer builds ten standard sizes of knock-down, walk-in coolers, with any other size built to order at $1.10 per sq ft of outside area. These coolers may be equipped with a 12-cu ft freezer compartment at a cost of about $150. A 5x6x7½-ft cooler with freezer and ¾-hp condensing unit lists at $683. It is estimated that this cooler will consume approximately 180 to 200 kw-hr per month with heavy usage. The freezer was designed to provide space equivalent to two lockers, with the outer cooler for aging beef and for general storage. One representative of this company believes there will be a definite trend away from locker storages in favor of privately owned equipment.

ADVANTAGES OF THE COLD-STORAGE LOCKER SYSTEM

	Number of times given
Advantages compared to home butchering and processing:	
1 Fresh meats available throughout the year	265
2 Eliminates work of home butchering, processing and canning	214
3 Freezing reduces the danger of waste or spoilage of meats	90
Advantages compared to purchase of meat at retail shops:	
1 Locker system effects a saving over buying meat at retail	236
2 A higher quality of meat is available	139
3 Satisfaction of using home-produced meat	59
Disadvantages of the cold-storage locker system:	
1 Distance from farm to plant	85
2 More expensive than home slaughtering and processing	52
3 Slowness of thawing out before meat can be used	28
4 Locker boxes too small	23

[3]Cold storage locker plants. Minn. Agr. Exp. Sta. Bul. 345.

Another company makes three single-temperature chest models of 6, 16, and 30-cu ft capacities selling at $165, $225, and $295. They have temperature controls with ranges of −15 to 45 F. Product freezing is accomplished through temperature control. This company believes their cabinets of these sizes will be directly competitive with locker plants, particularly where distances to lockers are great. The 30-cu ft freezer in the Chicago territory uses 80 to 100 kw-hr per month.

Two other companies both make chest model, two-compartment freezers. In one make the freezers are all of 8-cu ft size, with storage compartments of 8 to 32 cu ft, and in the other the freezers are 3 and 4¼-cu ft with 12 to 21½-cu ft storage. Both use small fans in the low-temperature compartments when freezing. A 26-cu ft cabinet of one make used 96¾ kw-hr in one month (June) on the Glen Gustafson farm near DeKalb, Ill. A representative of the other company states: "We feel that the 24-cu ft size is adequate for a family of four, 32-cu ft for a family of 6 or 7, and 40-cu ft for larger families."

LIMITED MARKET SEEN BY SOME MANUFACTURERS

A representative of the refrigeration department of one company believes the biggest use of freezers will be for carrying out the complete freezing and storage process on the farm while the representative of another company states his belief that "the market for the individual freezers is with the wealthy gentleman farmer or among wealthy rural dwellers rather than with the actual farmer."

Two other companies are both making front-opening, reach-in, combination freezing and 40-F storage cabinets. One of them also makes a series of sectional reach-in coolers in capacities of 38 to 115 cu ft, with provision for freezing and storage compartments to suit special requirements. Plates containing an eutectic solution are used for sharp freezing and also for cooling the cabinet.

Another manufacturer now has freezing and storage chests of 17 and 26-cu ft capacity. Both have 5-cu ft freezing compartments. The cabinets will retail at about $350 and $450. Storage cabinets without freezing compartments are also made for expanding storage capacity without purchasing an additional freezing unit. Freezing compartment coils may be completely cut off for defrosting. A representative of this company is of the opinion that locker plants will continue but that many farms will change to home freezing.

A new device just developed by this same company is a small waterproof, low-temperature fan supported on a wire framework, to be placed in the center of the freezing compartment when foods are to be frozen. The wire frame insures open space for air circulation, and the fan creates an air blast for quick freezing.

Another company makes several models with shelves for freezing.

Economics of Farm Freezing and Storage. A 40-cu ft farm freezer costing $600, and with an assumed life of 15 yr, would cost about $8.65 per month to use:

Interest on one-half of $600 at 6 per cent	$18
Depreciation figured on 15-year life	$40
Annual repairs, estimated	$10
Operating current for 12 mo at 3 cents per kilowatt-hour	$36
Total	$104

These figures are rather liberal, as it is probable that first costs will decrease and that anyone using equipment of this size would be buying current for less than 3 cents per kilowatt-hour. Assuming an original cost of $400 and electricity at 2 cents per kilowatt-hour, the monthly cost would be about $6.

Locker storage of equivalent size, namely, about 6½ lockers, at $1.00 per month would cost $6.50 per month. These figures might scare many farmers, but so would figures similarly presented for automobiles, household refrigerators, even the grain binder which is used only a few days each year. Yet automobiles, household refrigerators, and binders or combines are popular items of farm equipment.

The purposeful farmer who figures costs and possible returns in advance, would probably make money on a home freezing plant. He may use a freezer for increasing the market and price of homegrown products sold at the farm or roadside stand. He may even establish his own brands of frozen specialties. This same business farmer, if he uses a locker, will realize that he must figure at least a portion of the mileage on his car to and from the locker plant at about 3 cents per mile. The more likely procedure, however, is for farmers to consider the desirability of home freezing equipment and take a chance on the economics working out.

Small farm freezers will, in general, have to justify themselves on the same basis as other equipment which improves the standard of living while offering some possibilities of additional income.

Agricultural Engineering Students Recommended for Draft Deferment

DRAFT boards are urged to give special consideration to deferment of graduate students in scientific, technological, and educational schools and students in engineering and health services, in a resolution just passed by the New York Branch of the American Association of Scientific Workers.

After July 1, the group deferment of students expires, and the local draft boards must consider the continued deferment of each student individually on its own merits. A student in these nationally important fields is put into the deferred classification if the local board finds him a "necessary man."

The Scientific Workers urge local boards to take advantage of information that might be furnished by the National Roster of Scientific and Specialized Personnel, and to judge the usefulness of such a student by standards provided in a report made at the request of Dr. C. A. Dykstra, director of the Selective Service System, by the National Academy of Sciences and the Sub-Committee on Military Affairs of the National Committee on Education and Defense.

According to this report, defense needs clearly require careful consideration of requests for deferment for students in the following fields:

Medicine, dentistry, and pharmacy. Biology, bacteriology, and any other branch of biological science which bears directly upon problems of medicine or the public health, safety, or interest.

Chemistry. Physics.

Geology and geophysics, including such specialized fields as meteorology, hydrology, and cartography.

Engineering, including civil, electrical, chemical, mechanical, agricultural, sanitary, and mining.

"One of the primary functions of the administration of the Selective Service Act requires that military personnel be developed with a minimum disruption of those spheres of national activity which are of great social value. It is important, therefore, to protect the continuity of the development of professional and technically trained persons."—*From "Science News Letter" for March 22, 1941.*

Equipment for Terrace Construction

By J. T. McAlister
FELLOW A.S.A.E.

TERRACING has been a common farm practice for erosion control throughout the Southeast for almost 100 years, together with contour cultivation. In recent years, as a result of programs of Federal and State agencies, terracing is being incorporated into complete water disposal plans and is being coordinated with other soil conservation practices, such as strip cropping and the use of perennial vegetation. On cultivated areas with moderate slopes it is regarded as an essential practice in planning complete land-use programs on farms.

Terracing is the farmer's major earth-moving job. It has been estimated that if all the terracing needed on farms in the United States were done, the earth moved would equal that required to build 40 Panama Canals. Spread out over many fields and acres, however, earth moving operations involved in terracing are not spectacular or impressive when compared to operations involved in large earth fills, dams, highways and canals. Nevertheless, the job is so great that with all the work that has been done we can hardly consider that we have more than made a beginning.

Since the drainage-type terrace is now most commonly used in the Southeast, our equipment should be adapted to its construction. Certainly nothing short of an adequate terrace should be considered, yet entirely too much labor and power has been wasted by farmers in building terraces that do not meet minimum requirements. While there are many factors that contribute to an adequate terrace, the most important are (1) adequate channel capacity, (2) cross-sectional slopes flat enough to permit the operation of tillage equipment along the terrace without undue hindrance, and (3) channel design that will permit maintenance operations to be merged with ordinary seedbed preparation, such as plowing.

In constructing drainage-type terraces it is important to keep in mind that the terrace ridge is incidental and that major emphasis should be placed on constructing the channel of sufficient size to carry the anticipated runoff. The ridge is a result of channel excavation, since it is easier to move earth down hill. This approach to the construction problem is regarded as fundamental, and if kept in mind, useless movement of earth will be avoided and low costs will result.

A paper presented before a meeting of the Southern Section of the American Society of Agricultural Engineers at Atlanta, Ga., February 6, 1941. Author: Head, regional equipment section, Region 2, Soil Conservation Service, U. S. Department of Agriculture.

On every farm there can always be found an ordinary moldboard plow, and a wooden V-drag is easily constructed. These have been the most commonly used terracing implements on southern farms, yet the resulting terrace is generally inadequate and unsatisfactory. The time required to construct an adequate terrace by means of a plow and V-drag is much greater than when certain other types of light equipment are used. Furthermore, there is a tendency to stop before an adequate cross section has been obtained. Seldom is it possible to obtain the desired cross section with one plowing and operation of the drag. This is due to the limited distance that earth can be moved with this equipment and the difficulties encountered in moving loose earth over loose earth. By reciting the difficulties involved in the use of this equipment it is not intended to convey the impression that an adequate terrace cannot be built with it. By repeating operations on the same terrace at intervals after settlement and with favorable soil conditions, a satisfactory job may be accomplished, but costs are likely to be out of line when compared to the use of other types of equipment.

In the final analysis, cost is the main factor in the selection of the type of equipment to be used. Costs must always be kept in line with benefits secured, and a constant effort must be made to reduce them. Because the factors affecting costs are so numerous and variable, no conclusions should be reached until all factors are given due consideration. Operating efficiency of any type of equipment is greatly influenced by soil conditions. In hard ground, auxiliary machines, such as scarifiers and rooter plows, may be necessary. Sticky gumbo-type soils clog machines, causing delays, and lowering quality and efficiency. Such conditions generally call for more power than is ordinarily available. Condition of fields, their slope, shape, and degree of erosion also influence cost. The presence of numerous gullies, embedded stone, stumps, and roots increase costs; whereas, the potential value of the land is generally less than that of other fields where more favorable conditions exist.

More recent developments in the use of light horse-drawn equipment have centered around the slip scraper, known in some sections as the drag pan or drag scraper. This implement is available in 3, 5, and 7-cu ft capacity, requiring one, two, or three mules as power units. Where soil conditions are favorable, small size Fresnos can be used in the same manner as the slip scraper. Sufficient work has already been done in every southern state to demonstrate

(Left) Recent field trials with motor graders indicate that they will replace many of the two-man units of track-type tractor and two-wheel terracer. (Center) This view shows terrace maintenance with a 4-ft disk tiller. (Right) Slip scrapers with teams represent balanced units for terrace construction on small farms. This combination is most satisfactory where only animal power is available

that the use of this equipment has many advantages and is perhaps most satisfactory where teams are the only power available. Among the advantages are low first cost, adaptability to available power, completion of terrace construction in one operation with adequate cross section as construction proceeds, completion of fills in low places, and completion of outlets along with terrace construction. However, farmers have been slow to see these advantages. They regard this method as slower than plow and V-drag construction. This objection will not hold, however, when channel cross sections obtained by the two methods are compared. Costs also will be found to compare favorably when the amount of earth moved and the channel section are considered. Some regard the operation of the scraper as harder work on men and teams than construction with plow or drag. As an indication of the cost of this type of construction, Mr. J. D. Duke of Fort Valley, Ga., whose farm is typical of many now using this method, reports the cost of constructing 11 mi of terraces at 40 cents per 100 lin ft or $21.12 per mi.

TERRACING EQUIPMENT FOR SMALL FARM TRACTORS

The small farm tractor equipped with rubber tires has becomes popular on southern farms in recent years, and as a result there is a decided demand for terracing equipment suitable for operation with these tractors. Equipment available consists of light terracers, equipped with blades, or one-way disk plows. Light blade-type terracers have been used extensively with teams and farm tractors. However, the results obtained are not altogether satisfactory, except where soil conditions are uniformly good. In most cases the terracers are designed for four-horse teams or larger, and when used behind tractors weaknesses in design develop which reduce effectiveness of the equipment. There is a definite need for a blade terracer that can be mounted directly on a small farm tractor for one-man operation by power control. Experience to date indicates that the most satisfactory equipment for this type of tractor is the regular cylinder disk plow, especially those types attached directly to the tractor. This arrangement permits more definite depth control, backing, and ease in turning. The design and manufacture of more suitable terracing equipment for the farm type tractor presents a definite challenge to agricultural engineers, research organizations, and implement manufacturers.

Prior to 1933, practically all equipment used in terrace construction in the South was of the light horse-drawn and farm tractor type. Since 1933 these types of equipment have continued in use, along with track-type tractors of 40 to 50 hp and two-wheel blade terracers. This heavy equipment came into use when efforts were made to speed up the program in soil conservation instituted by state agricultural extension services through county agents, and by the U. S. D. A. Soil Conservation Service and other government agencies. The use of this type of equipment indicates a recognition of the magnitude of the job, as well as of the fact that satisfactory terrace construction i san undertaking requiring more power than had been available heretofore. Heavy power equipment is now being used for terrace construction in every southern state, as well as in many states of the Midwest. When equipment has been manned by experienced operators, results have been uniformly satisfactory, even under adverse conditions. While use of heavy equipment has given decided impetus to the work, there remains the need and demand for light equipment for farmers who cannot afford to pay rental or contract charges on heavy equipment, and who have teams and light tractors available for such work. There is a place for both types of equipment, and we cannot foresee a time anywhere in the near future when we may expect the job to be completed. With the formation of soil conservation districts, and the resulting coordinated land-use plans that have been made on thousands of farms, a tremendous work load has been created looking toward establishment of the practices planned. This is the farmer's work load, and he will need all the help and all the equipment he can get.

The first cost of heavy equipment limits its ownership to groups such as terracing associations, or to contractors who, in turn, make it available to individual farmers for a rental fee. Reports compiled over a period of 6 years from 1934 to 1940, inclusive, show that approximately 900,000 acres have been terraced under the supervision of various government agencies in seven southern coastal states. It is estimated that approximately 80 per cent of this acreage was terraced with heavy equipment.

With such a large accomplishment, it is natural to ask what is the trend as to the continued use of heavy equipment. Past experience is now sufficient to show that group ownership and operation requires definite organization and supervision of the work, if a reasonable degree of efficiency is to be obtained. In many cases, rental charges have not been sufficient to take care of this supervision, which has been furnished by government agencies, and in many instances is now being discontinued. To increase fees to cover supervision would make costs out of line for the average farmer. While it is estimated that there are approximately 300 heavy units still in operation throughout these seven southeastern states, just how many of them will be replaced when they are worn out is hard to foresee.

MORE TERRACING WITH MEDIUM-SIZE EQUIPMENT

What then will take their place? The terracing load is on the increase. Probably a smaller size track-type tractor with blade terracer, of lower initial cost and being more mobile, will replace some units. Recent field trials with small road patrols mounted on rubber show considerable promise and have as advantages, one-man control, easy transportation for long distances under their own power on paved roads at reasonable speeds, ability to cross terraces and gullies easily, power-operated blade, ability to reverse blade without reversing machine, low operating cost, and the fact that the first cost is lower than for similar capacity in a track-type tractor and terracer. Its main disadvantage is difficulty in steering, especially around sharp curves and in turning at terrace ends. This is somewhat offset by instant control available for blade adjustment. If experience proves that these advantages are sound, this type of heavy equipment, no doubt, will replace many existing units, since the advantages will tend to reduce need of supervision, increase mobility, and reduce cost.

To summarize, we would say that there is a definite challenge to all agencies to keep in mind the magnitude of the problem of terrace construction, its coordination with other soil conservation practices in land-use planning, the need for constructing an adequate terrace, and above all, the need of adequate maintenance of all soil conservation measures as the determining factor in measuring results. Terrace construction and maintenance, while representing a tremendous undertaking in the aggregate, are relatively simple problems of the individual farm. Best results are obtained when the work required becomes a part of the regular farm operations. Since terrace construction is basically a problem of earth moving, any type of equipment selected for this purpose should be evaluated on its capacity for economical movement of earth under the varying soil conditions encountered.

Some Earthquake Damage Results

By C. C. Huskison

ON May 18, 1940, at approximately 9:37 pm, MST, an earthquake of severe intensity rocked the Imperial Valley in southern California and the Yuma Valley in Arizona. The initial shock was followed by a series of aftershocks of less intensity, culminating with another severe temblor at 10:50 pm. Smaller tremors continued at varying intervals and intensity for several days. The first and most widespread shock was reported to have extended as far as San Diego, Parker Dam, Phoenix, and Tucson. The quakes also were felt in northern Lower California.

Most of the damage at El Centro and Calexico in the Imperial Valley occurred during the first severe shock, whereas Brawley, a few miles to the north, experienced its greatest damage at 10:50 pm, more than an hour later. Thus, at Brawley the first temblor served as a warning for the more severe local shock which followed. Loss of nine lives was reported in the Imperial Valley area, and many persons were injured by falling bricks and glass. There were no injuries or deaths reported in the Yuma district.

Accurate estimates of the total damage attributed to these earthquakes are not available. However, it is safe to say it amounted to several millions of dollars. In both the Imperial and Yuma Valleys considerable damage occurred to the irrigation, drainage, and highway systems. The All-American Canal and several of its related structures suffered considerable damage, the lateral displacement of the canal banks amounting to as much as 14.8 ft at a point a few miles east of Calexico.

Damage to structures and canals of the Imperial Irrigation District's system in California and Mexico approximated $235,000. The Alamo Canal, in Lower California, main feeder for the entire system, suffered eight or more major breaks. The Solfatara Canal, also in Mexico, was completely destroyed for a distance of about 11 kilometers. Canal banks which had been 10 ft high appeared to have sunk vertically, remaining only a foot or two above the bottom of the canal. The entire area adjacent to the canal was so flooded that it was impossible to determine just what had taken place. It appeared, however, after the canal had been reconstructed, that lurching rather than a general subsidence was responsible for the resulting conditions.

The New River flume on the West Side Main Canal, a timber structure 1400 ft long, was demolished.

All available men and equipment were rushed to repair the Alamo and Solfatara canals. Ripening cantaloupes required immediate irrigation and the loss of this crop alone would have amounted to over $1,500,000, had it taken as long as two weeks to effect repairs. Through the co-operation of the Mexican government during the emergency certain restrictions, pertaining to the use of foreign labor and transporting of equipment and materials, were removed. Thus it was possible to repair these important canals in record time and it is believed no actual crop damage occurred.

In the Yuma Valley, an area extending from Gadsden to about 4 mi south, and 12 mi north, and eastward from the Colorado River about 4 mi, was badly shaken. Damage was chiefly to canals, drainage ditches, flumes, bridges, county roads, and State Highway 95.

Miles of drainage ditches were obstructed, the bottoms of the channels being pushed up, in some cases, as high as the adjacent ground surface. In one instance, water from the drainage ditch flowed out over surrounding land. In some places subsidence of the canal and ditch banks occurred. Bridges and flumes buckled, the piles apparently being shoved up by the repeated pitching of the earth. The county highway bridge on 19th Street, over the Southwest drain, was pushed up in the middle and left standing about 6 or 7 ft above the adjacent pavement (Fig. 1). Several other county bridges were affected in like manner to a lesser extent.

On State Highway 95, about a mile north of Gadsden, the bridge over the South drain buckled to a height of about 4 ft. This was the only bridge damaged on the State Highway. All of the bridges damaged by the quake in the Yuma Valley were wooden structures on timber piling.

County road damage amounted to about $15,000, and between $5,000 and $6,000 was expended on repairs to State Highway 95. These amounts, of course, do not cover eliminating the permanent roller coaster surface condition which resulted in numerous places. These can only be satisfactorily remedied by rebuilding the sections affected. Hundreds of serious pavement cracks, both horizontal and transverse, occurred. Numerous small irrigation syphons under the highways were cracked open and it was necessary to repair many of them before irrigation could be resumed. Eleven such structures were repaired on State Highway 95 alone.

Between 10 and 12 mi of drainage ditches on the Yuma project required re-excavating to an average depth of 4 ft. This work has been under way for several months and has not yet been completed. An official estimate of the damage to the project was set at $15,000.

A paper presented before a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Tucson, Ariz., February 8, 1941. Abridged. Author: Resident engineer, (Yuma), Arizona Highway Department.

Fig. 1 (Left) County road bridges near the 40-mi fracture suffered severely. In this case the bottom of a drainage ditch was raised about 7 feet, pushing the center of the bridge up with it. Fig. 2 (Center) Fine sand spread over an alfalfa field from one of the temporary geysers which developed along the line of fracture. Fig. 3 (Right) Small flumes were damaged by vertical and lateral displacement of their foundations.

Farm lands were damaged to an undetermined extent. While it is not believed the ground surface was seriously disturbed over any considerable area, in some fields the upheaval and subsidence was serious and restoration to irrigating levels was costly. Subsidence, in some instances, apparently still continues and the moot question in the minds of those whose lands are affected is "When will the subsidence cease so that we can relevel our land and again place it under cultivation?"

During the shaking, geysers literally by the thousands spurted from the ground along cracks in the surface crust. These so-called geysers carried fine sand to the surface (Fig. 2) apparently from considerable depths. In places the sand deposits amounted to several cubic yards and it was necessary to scrape them from the fields. The spouting was reported to have varied from 2 to 6 ft above the ground surface and continued for a period of from 15 to 30 min. Some fields received the equivalent of a full irrigation where the maximum amount of ground water forced to the surface.

The railroad grade along the Colorado River levee was seriously damaged for approximately 4 mi in the vicinity of Gadsden. Waves were left in the grade averaging one foot or more from crest to trough. Four other sections between Yuma and Somerton were affected. It was necessary to temporarily crib up the tracks and later, as time permitted, to level and reballast the roadbed.

One of the most serious and costly results of the disturbances was the damage inflicted on flumes belonging to the Yuma irrigation project (Fig. 3). These presented a spectacular picture in their twisted and buckled condition. At least 20 such flumes were practically demolished. Piling under the flumes was, in general, raised to the same extent as the drain bottoms were lifted.

Considerable movement took place along the international boundary line a few miles east of Calexico. Some survey monuments were displaced, at least 9 ft and possibly more, from their original positions. A preliminary check was made by engineers of the All-American Canal project. However, no definite conclusions were reached and undoubtedly an accurate resurvey will have to be made before the true conditions will be known. The question arises as to whether a portion of Mexico moved up into the United States, or vise versa. The answer, it is presumed, will eventually be determined by the International Boundary Commission.

Linked with the problem affecting the location of the international boundary is the serious one concerning section lines, land boundaries, rights-of-way, etc., in the two countries. Many resurveys will be necessary and legal battles probably will occur before the maze is untangled to the satisfaction of all concerned.

As to the cause or causes of the disturbances, there seems to be a difference of opinion between authorities. The California Institute of Technology in its seismological laboratory at Pasadena, conducted a preliminary investigation. Seismograms from nine stations were used in analyzing the results. I quote parts of a letter from Dr. Richter of the Institute to T. A. Clark, engineer on the All-American Canal project:

"We have discussed the effects in the Yuma Valley repeatedly, with regard both to cause and to mechanism. There is no reasonable doubt that they are due, in major part, to the disturbance of ground water by the passage of the surface waves of the Imperial Valley earthquake. Neither seismograms nor any other available data would rigidly exclude the possibility of another shock, closer to or even under Yuma Valley, originating shortly after (perhaps set off by) the principal shock; but neither is there any direct evidence to support such a suggestion. . . .

"Many of the smaller cracks, especially those running parallel to the irrigation system and along levees, are clearly due directly to shaking and call for no special explanation. Discussion mainly refers to the system of cracks running roughly NW-SE between Gadsden and Somerton. This crack system has a distinct resemblance to the northern part of the fault trace near Imperial, where the displacements decrease and the trace ceases to be straight and follows the topography. However, there is little relative displacement of the sides of the cracks, and the NW-SE trend may be determined by the shearing effect of the surface waves crossing the area. . . . .

"The other effects are plainly connected with the compressional component of the surface waves. The ejection of ground water in small geysers and sand spouts—a usual effect in shocks of this size—is sufficient evidence that the compression existed. The raising of the bottoms of canals and ditches is presumably due to this pressure, acting most effectively where the overburden is least."

The above quotations, please remember, refer only to conditions in the Yuma Valley. Various other theories have been advanced.

AUTHOR'S ACKNOWLEDGMENT: Credit is given for assistance in the preparation of this paper by T. A. Clark, office engineer on the All-American and Gila projects; Henry Frauenfelder, president of the Yuma County Water Users Association; and C. B. Elliott, superintendent of the Yuma project for the U. S. Bureau of Reclamation, who furnished much of the data and loaned the photographs accompanying this paper.

A.S.A.E. Officers for 1941-42

AS A result of the annual election of officers of the American Society of Agricultural Engineers just held, the newly elected officers who will take office following the annual meeting of the Society in June, are as follows:

President, Geo. W. Kable, editor, "Electricity on the Farm."

Councilors (three-year term each), C. E. Frudden, executive engineer, tractor division, Allis-Chalmers Mfg. Co., and Ray W. Carpenter, head, agricultural engineering department, University of Maryland.

The new Council of the Society for the year 1941-42 will include the above-named officers, together with K. J. T. Ekblaw and E. E. Brackett, past-presidents; R. H. Driftmier, B. D. Moses, E. A. Silver, and E. G. McKibben, councilors.

The newly elected Nominating Committee of the Society will consist of R. U. Blasingame (chairman), H. H. Sunderlin, and T. E. Hienton.

Fire Damages Agricultural Engineering Building at Ames

A FIRE in the agricultural engineering building at Iowa State College, the morning of March 31, caused damage estimated at $100,000. It was discovered at 7:00 am in the east wing, where it apparently started in corncobs used there in corn drying experiments. The main blaze was believed under control at one time before much damage was done, but reached the space between the ceiling and the roof, and some partitions, from which it spread rapidly throughout the building.

Most of the movable farm and office equipment was removed before the fire spread, but there was an extensive loss of other administrative and research equipment and records.

Ironically, the fire started in the same wing in which fire-prevention research had produced results which have considerably reduced the Iowa farm fire loss and fire insurance rates.

6 BIG REASONS WHY "CATERPILLAR" MOTOR GRADERS FIT TERRACING NEEDS!

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2. ***Fast Mechanical Controls*** These give the operator quick, easy control over proper angle and pitch of blade. This encourages the new operator to develop skill. And a skilled operator moves the yardage!

3. ***Tandem Drive—Rear-Mounted Engine*** This combination feature, as developed by "Caterpillar," assures adequate traction for the heavy work of moving earth.

4. ***Excellent Visibility*** Operator has a clear view of the machine and the work, fore and aft.

5. ***Mobility*** These Motor Graders have quick, self-transport over all kinds of roads—a time-saver in moving from job to job.

6. ***Proved Attachments*** The scarifier, for example, provides the means for shattering hard soil to construct terrace channels—without the need for a separate machine unit.

And of course these reasons are bulwarked by "Caterpillar's" world of earth-moving and erosion-control experience—and made extra potent by "Caterpillar" Diesel economy. Your inquiry is invited.

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DIESEL ENGINES TRACK-TYPE TRACTORS TERRACERS

NEWS

Caraway Bill Would Foster Structures Improvement

IN the form of an enabling act, a Bill (S. 1041) recently introduced in the United States Senate by Senator Caraway of Arkansas, would provide authority for the appropriation and expenditure of federal funds "To provide for better rural homes and farm structures through further endowment of cooperative agricultural extension work, agricultural research, and resident instruction in the land-grant colleges."

Title I of the Bill covers authorizations for extension amounting to $1,000,000 for the fiscal year 1942, and an additional million each successive year, up to a maximum total of $5,000,000 for the fiscal year 1946 and each succeeding year. Two per cent of sums appropriated under this title would be available to the Secretary of Agriculture for administration; the balance would be apportioned among the states and territories on the basis of a fixed sum of $10,000 to each, and the remainder distributed one-third in proportion to farm population, one-third in proportion to rural population, and one-third in proportion to average gross farm income. To qualify for its allotment from any appropriation exceeding $1,000,000 under this title, each state would have to appropriate one-fourth of such allotment for the same purpose.

Under Title II a maximum of $1,000,000 per fiscal year, beginning with 1942, would be authorized for research. Not more than 40 per cent could be allotted to the U. S. Department of Agriculture, and not less than 60 per cent allotted to the states and territories on an equal basis.

Title III would authorize a maximum of $265,000, minus a maximum of $10,000 for administration, to be allotted equally among the states for the training, in land grant colleges, of additional personnel to carry out the extension and research programs contemplated.

Administrative features in the above and in Title IV cover manner of payment, responsibility, and checking on compliance by states participating. They provide that authorizations of this Bill are in addition to other and previous authorizations for similar purposes, and that the work contemplated should be coordinated with similar work financed under other authorizations. The extension, research, and teaching to be authorized by the Bill are described in terms apparently broad enough to permit effective administration and direction of activity along lines of greatest need and opportunity.

Copies of the Bill as printed by the government are limited. Verbatim copies have been mimeographed by the American Society of Agricultural Engineers and will be furnished to interested persons on request to the Society's headquarters at St. Joseph, Mich.

Minnesota Farm Structures Conference

A ONE-DAY farm structures conference for rural builders and building material dealers was held March 7, at University Farm, St. Paul, Minn., under the direction of the division of agricultural engineering, University of Minnesota.

H. B. White served as chairman of the conference, which has developed as an annual event in the program of short courses offered by the University department of agriculture.

Program features included talks on "A Building Program," by A. J. Schwantes; "Different Types of Concrete for Farm Use," by C. G. Widseth; "Quality Concrete on the Farm," by D. G. Miller; "Treated Lumber in Buildings," by R. L. Smith; "Spray Painting," by C. B. Gracely; and "How and Where to Use Brick," by M. C. Madsen, during the morning session.

Afternoon talks included "Farm Structures Exhibit," by C. H. Christopherson; "The Dealer's Part in Good Building," by O. C. Lance; "Unusual Buildings," by R. Worthley; "Summer Conditioning of Homes," by C. K. Otis; and "Insulation and Moisture Condensation in Winter," by C. E. Lund.

The conference was advertised as "an opportunity to hear up-to-date information on materials, methods, and structures" to better enable the dealer and builder to meet his obligation to help the farmer "get the kind of structure that will most nearly meet his needs."

A.S.A.E. Meetings Calendar

June 23-26—Annual Meeting, Knoxville, Tenn.

Sept. 29-Oct. 1—North Atlantic Section, Jackson's Mills, W. Va.

December 1-3—Fall Meeting, Stevens Hotel, Chicago.

Joint Locker Plant Committee Organized

A JOINT Industrial Committee on Frozen Food Locker Plants has recently been initiated by the American Society of Refrigerating Engineers. It is to act as a fact-finding and standardization committee for the locker equipment industry. The A.S.A.E. has been invited to representation on the committee and President Brackett has appointed T. E. Hienton, R. L. Perry, C. P. Wagner, F. D. Yung, and H. D. Bruhn to represent the Society. Mr. Hienton will serve as chairman and spokesman of the A.S.A.E. representatives.

It is anticipated that other organizations which will be represented, in addition to the A.S.R.E. and A.S.A.E., will include the American Institute of Food Technology, the National Frozen Food Locker Association, the U. S. Department of Agriculture, and some of the land-grant colleges.

Georgia State Section Plans Fishing Trip

DEEP sea and river fishing will be the principal activity at a meeting of the Georgia State Section of the A.S.A.E., April 11 to 13. Rooms, meals, and boats will be obtained at the base of operations, the Crooked River Club near St. Marys, Ga.

A supper, get-together, and games are planned for Friday evening, fishing all day Saturday, games Saturday evening, and breakfast and a choice of staying or leaving Sunday.

Sea fish caught in this vicinity include red snapper, sea bass, flounder, and other species, and the committee reports that the river is well stocked with whiting, trout, bass, drum, and sheephead.

Wives or dates of the Section members and guests are invited. The committee has asked for advance registrations to permit completing arrangements. Members of the committee are H. C. Seaton, Olin Hughes, and Hugh Roberts.

Personals

William E. Hudson and *Frank B. Lanham* are the authors of "Four Small Barns for Georgia Farms," a circular of general information on the structures, issued by way of encouraging farmers of the state to build barns adapted to their requirements, and as a guide to requests for working drawings and bill of materials, which the agricultural engineering department of the University of Georgia is prepared to furnish free on request.

W. M. Hurst is one of the authors of "Harvesting Pyrethrum," published as Circular No. 581 of the U. S. Department of Agriculture.

H. F. McColly has been appointed district designs and plans engineer of the Farm Security Administration, and will be located at the F.S.A. headquarters at 1025 Fourteenth St., Denver, Colo. For the past two years he has served as secretary and chief engineer of the State Water Conservation Commission of North Dakota, and previous to that was head of the agricultural engineering department at the North Dakota Agricultural College.

G. W. McCuen is the contributor of a viewpoint on "Agricultural Machinery and National Defense" which is published in the Engineering Experiment Station News for February, as one of a dozen interviews with engineering department chairman of the Ohio State University and Engineering Experiment Station.

(News continued on page 154)

"YOU CAN'T BEAT HIGH COMPRESSION for POWER and CONVENIENCE"

HIGH COMPRESSION GIVES YOUR CUSTOMERS

EXTRA POWER

Most modern tractors, like automobiles and airplanes, have "high compression" engines to get the extra available power out of good gasoline—deliver more power, do more work per hour than is possible with low compression engines of equal size.

EXTRA CONVENIENCE

Gasoline tractors get to work fast and stay on the job! They warm up quickly, aren't likely to stall, and don't require constant adjustments. They get more work done in less time.

EXTRA FLEXIBILITY

A gasoline powered tractor can be better and more quickly adjusted to the load and speed requirements of various kinds of field and belt jobs.

EXTRA EFFICIENCY

High Compression tractors offer the best buy in efficient farm power because they get more work done per gallon of fuel. And with gasoline there's practically no crankcase dilution to run up oil costs.

When you get right down to it, the only reason why a farmer buys *any* tractor is to get his work done. And the less he has to pay *per horsepower* for a tractor to do his plowing, reaping and other farm work, the more likely he is to buy. When you sell him a high compression tractor using good regular gasoline you're giving him today's best bargain in horsepower—with an *extra* measure of *all* the modern advantages he wants in a tractor. Tell your customers the facts about high compression. It will help step up your tractor sales.

ETHYL GASOLINE CORPORATION, *Chrysler Building, New York, N. Y., manufacturer of anti-knock fluids used by oil companies to improve gasoline.*

Personals

(Continued from page 152)

Earle K. Rambo is now acting head of the agricultural engineering department, University of Tennessee, while M. A. Sharp is on leave of absence until June 15, working on the national defense program.

Oscar W. Sjogren has been promoted to the position of sales manager of the Killefer Manufacturing Corporation, a subsidiary of Deere & Company, but will also continue as agricultural engineer in charge of research and development work.

F. E. Yung covers "Studies of Insulated Electric Brooders" in mimeographed Agricultural Engineering Progress Report No. 8 (January 1941) of the Nebraska Agricultural Experiment Station.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the March issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

John M. Anderson, field engineer, Structural Clay Products Institute, 102½ Welch Ave., Ames, Iowa.

Oscar H. Lowery, research fellow, Iowa State College, Ames, Iowa. (Mail) 2228 Lincoln Way.

Kenneth H. Parks, instructor and assistant agricultural engineer, agricultural experiment station, University of Idaho, Moscow, Idaho. (Mail) 116 N. Jackson St.

Frank A. Tetley, Jr., general manager, Tetley Nurseries, 3435 8th St., Riverside, Calif.

J. R. Werth, engineer, Rural Electrification Administration. (Mail) 708 Braxton Place, Alexandria, Va.

Lowell L. Whitaker, junior agricultural engineer, Soil Conservation service, U. S. Department of Agriculture. (Mail) SCS-30-N, Tularosa, N. Mex.

Student Branch News

TEXAS

By Joe W. Autry

OUR Student Branch is having a successful year, as evidenced by the fact that at present there are 78 paid-up members and attendance has been good at all the meetings.

At one of the last meetings of the first semester, the program was given over to several members of the faculty. F. R. Jones reviewed the history of agricultural engineering at A. & M. College and outlined the general fields of agricultural engineering. He also pointed out opportunities for agricultural engineers in the teaching profession. F. W. Peikert discussed the possibilities for employment in the field of farm power and machinery, and gave some of the opportunities in the farm equipment industry. Donald Christy outlined the possibilities in the field of soil and water conservation and possible openings for college graduates in the army.

The program at the next meeting featured a discussion by H. P. Smith, chief of the agricultural engineering division of the Texas Agricultural Experiment Station, on the development of the cotton picker. One of his major projects during the past ten years has been the development of a successful picker.

At the first meeting of the second semester F. C. Knight, manager of the Dallas Branch of the Massey-Harris Company, gave an interesting talk on the development of the combine-harvester and showed several reels of film on the combine and other machinery manufactured by his company.

At the following meeting a quiz program was conducted by the graduate students of the department. Questions were asked members of the Branch concerning various phases of agricultural engineering, with a cigar being given as an award for a correct answer.

Final plans have been completed for the annual agricultural engineering dance which is to be held April 18.

The Branch has decided to participate in "Ag Day" which will be held in May. Its purpose is to show the people of Texas the activities of the state Agricultural and Mechanical College.

A.S.A.E. Student Branch group at Texas A. and M. College

GEORGIA

By Harold McGill

THE Georgia Student Branch of the A.S.A.E. held its last meeting of the winter quarter on March 10, 1941. The speaker for the evening was Roy Bowden of the horticulture department, who spoke on the production of medicinal herbs in Georgia. He explained that there was an immediate need for a large production because of the war and stressed the importance of the agricultural engineer in helping to solve some of the unusual problems of harvesting and dehydrating the plants. A business session followed in which the officers for the spring quarter were elected. John Holliday was elected president; Olin Ginn, vice-president; Edwin Dottery, secretary; and Harold McGill, scribe.

The first meeting of the spring quarter was held March 24. The Branch voted to have a dance in the early part of the quarter. The feature of the program was a motion picture, presented by Goodyear Tire and Rubber Company, showing the importance of the rubber industry in national defense.

OREGON

By Bill Etter

SPRING has at last arrived at Oregon State College, and the A.S.A.E. Student Branch is bustling with activity. It resembles a colony of busy beavers preparing for the future.

With the coming of warm weather many jobs are being offered to the Branch. By using the loaned tractors and labor donated by the members, we hope to earn the money to send some representatives to the A.S.A.E. annual meeting at Knoxville.

The new year was given a sendoff by a faculty party the second week of school, and according to numerous reports everyone had a good time.

The annual Agricultural Club banquet held March 6 was the highlight of the term's social activities. The Branch was represented by many members and by having several prominent men of the Northwest as their guests. These men were the heads of implement companies and other organizations who have done much for the Branch in the past.

With the term now ended, the members are preparing for the final lap before the annual meeting, which they hope to take you by storm, or maybe by airplane.

To Increase
THE EFFICIENCY OF
INCOME PRODUCING FARM BUILDINGS

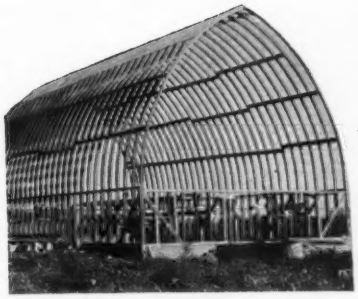
Efficiency in tractors and implements is an easily understood factor in farm economy. Any new device that promises increased production at lower costs is eagerly accepted. Farmers understand efficiency in terms of tools because they are conscious of the fact that implements do work.

But there is another type of equipment on the farm that does work and affects income. We refer to farm buildings — the structures that promote sanitation and reduce mortality in young stock — the buildings that increase livestock production and reduce labor hours — the proper storage of grains that protects the full feeding value of crops — machinery sheds and shops that stay depreciation and prolong the life of farm implements.

Such buildings work. They make vital contributions to profits. Accordingly, their efficiency should be the highest to meet the present and changing needs and methods of agriculture.

America's great chore is to build, repair, and remodel its farm structures. To this chore, Agricultural Engineers are applying their experience and talents. And to their vital work, Weyerhaeuser makes available 4-Square ready-to-use, precision lumber. This improved lumber is properly seasoned. It is available in a variety of species and grades for every structural need. Its accurate lengths and sizes eliminate needless sawing, fitting, and material waste. Its squared ends and edges assure tight joints, full bearing, and better workmanship.

Correctly designed farm buildings, properly built of 4-Square precision lumber, give more years of service — plus the added value of economical remodeling to suit new needs. Buildings, built of good lumber, are more adaptable to change than those made of any other material.



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is designed and engineered for many types of farm structures. Rilco rafters are glued in a curved form with a clamping pressure of 100 pounds per square inch. They arrive on the job ready to set up. Detailed Booklet on Rilco Rafters will be sent on request.

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There is a lumber item for almost every building requirement in the Weyerhaeuser 4-Square Line, together with many lumber specialties. Accurately illustrated and detailed, this book gives the ready-to-use lengths and sizes of 4-Square Lumber available at local 4-Square lumber dealers.

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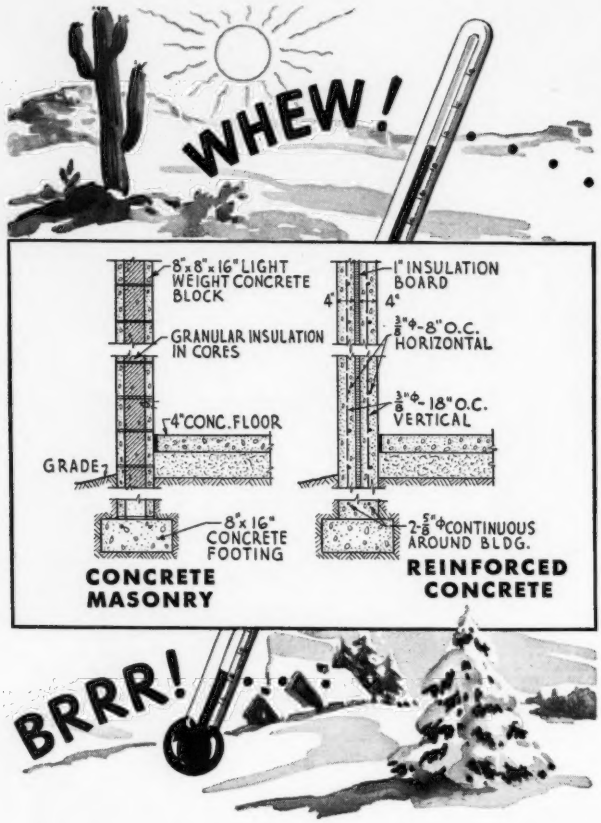

CONCRETE WALL DESIGNS

offer year-'round barn comfort

QUESTION: Can walls of low thermal conductivity be designed to use either concrete masonry or reinforced concrete?

ANSWER: Yes! Tests at the University of Minnesota have shown very satisfactory insulative values for wall designs of concrete and concrete masonry.

QUESTION: What range of conductivity?

ANSWER: A wide latitude. The above tests, sponsored by the American Society of Heating and Ventilating Engineers in cooperation with the Portland Cement Association, showed coefficients "U" ranging from 0.30 down to 0.10, depending on wall thickness, kind of aggregates and method of wall insulation.

QUESTION: Can good insulative quality be obtained *economically* with concrete?

ANSWER: By all means! First cost is little if any higher than for other quality construction, and availability of local materials and home labor on the farm often make concrete lowest. Ultimate cost, considering long life and low upkeep, is a minimum with concrete.

For year-'round comfort, firesafety, economy and long life, encourage the design of farm structures with concrete. Let us send you thermal test data for typical insulated concrete walls.

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Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

SOIL TREATMENT SUGGESTIONS ARE RESULT OF STUDY IN SUBIRRIGATED SAN LUIS VALLEY, *J. W. Tobiska.* Colo. Farm Bul. (Colorado Sta. Fort Collins) 2 (1940), No. 4, pp. 4-6. Conditions in the area named approach those of solution culture in an inert supporting medium, the soils being coarsely sandy and adapted to the practice of supplying irrigation water from below the surface. High yields have been obtained, but salinity and alkalinity have appeared at some points. Soil solution from the bad spots should be analyzed before treatment is attempted. Fertilizers free from chlorides and from sodium salts should be used where chlorine and sodium compounds are already present in high concentrations. Alkalinity is to be dealt with by means of organic fertilizers, sulfur, or gypsum, Ammoniated phosphates increased the yield and quality of potatoes where nitrogen and phosphate deficiencies had been found. Ammonium sulfate is preferred to nitrates. Calcium and magnesium deficiencies should be met by applying the sulfates of these elements rather than limestone or dolomite unless the alkalinity is less than that indicated by pH 7.5. Conditions in the utilization of these sandy soils by irrigation from below approach those of water culture sufficiently closely so that too high a concentration of the soil solution is to be avoided when possible. In any event, the solution should contain the mineral nutrients in proper ratio or balance.

COOLING, STORAGE, AND TRANSPORTATION OF MILK AND CREAM, *P. A. Downs and F. D. Yung.* Nebraska Sta. (Lincoln) Cir. 65 [1940], pp. 20, figs. 24. This is a nontechnical discussion of most of the common methods of cooling milk and cream and of maintaining a temperature low enough to prevent spoilage or deterioration during storage and transportation. Emphasis is placed on the proper cooling and storage of milk and cream for consumption on the farm as well as for marketing.

FLOOR FINISHES: ATTRACTIVE, EASY TO CLEAN, DURABLE, *C. H. Jefferson.* Michigan Sta. (East Lansing) Cir. 172 (1940), pp. 22, figs. 11. The author briefly discusses oil, varnish, and paint or enamel floor surfaces, pointing out the time-consuming nature of the oil treatment when done thoroughly enough to produce a lasting surface and the impossibility of avoiding "traffic lanes" of wear and discoloration in the use of varnish, shellac, or lacquer surfaces, a disadvantage due to lack of penetration and giving rise to wear of a nature such that refinishing the worn areas to match the rest of the floor is usually impossible except by resanding with concomitant excessive wearing down of the wood itself. The penetrating floor seals, so made as to penetrate only a short distance into the pores of the wood and to harden at the surface, are considered adequate to seal the surface of the wood against moisture, dirt, and substances causing stains, while at the same time they have the advantage, over the hot-oil treatment, that the floor may be used 24 hr after the application of the seal. Such finishes can usually be renewed in worn areas without need for refinishing the entire floor. The application of such finishes to new floors and their use in refinishing old floors are discussed in detail, and their use on inlaid linoleum and on concrete floors is also taken up. The use of waxes of various types is dealt with.

DYNAMOMETER TESTS OF DRAFT HORSES, *R. W. Phillips, M. A. Madsen, and H. H. Smith.* Utah Sta. (Logan) Cir. 114 (1940), pp. 14, figs. 5. The study reported in this circular is based on records of 2,485 entries in pulling contests in Utah and southern Idaho during the years 1931-39. The average body weight of all teams entered was 2,872 lb. The average tractive pull recorded was 2,385 lb. The correlation between body weight and tractive pull for the entire group was 0.6, ranging, in individual years, from 0.56 to 0.65. The regression, indicating the increase in tractive pull for every 100 lb increase in body weight, was 64.8 for the entire group and varied from 55.8 to 84.4.

The usefulness of dynamometer records is discussed, and the need for studies of the relationship between these records and ability to do farm work is emphasized.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE PENNSYLVANIA STATION, Pennsylvania Sta. (State College) Bul. 399 (1940), pp. 3-5, fig. 1. With a view to more efficient design and operation, the principles of hitches for tillage machinery have been studied by A. W. Clyde, who has also investigated means for reducing plow damage. The advantages and dangers of electric fencing are briefly discussed by J. E. Nicholas and F. L. Bentley, and variations in the capacity of feed mills are taken up by Nicholas. *(Continued on page 158)*

SPRING FRESHETS

sound a "hurry call" for Clean Ditches

Before the blast. Ditches like this dam freshets, delay planting

Shooting a 300-foot section

Water coming down the ditch—which averages 6′ wide at top, 3½′ deep

.... *and* ATLAS EXPLOSIVES

bring quick, economical action

SPRING freshets flood fields and hold up planting—unless ditches are clean to carry the extra water load.

Ditching with dynamite is efficient—effective—economical. Explosives are easily transported to the job. No extra equipment is needed—and labor costs in using are low. In making ditches and cleaning ditches, Atlas Farmex Ditching explosives give quick action and favorable results. They are especially designed for the job that is often a necessary part of Land Conservation.

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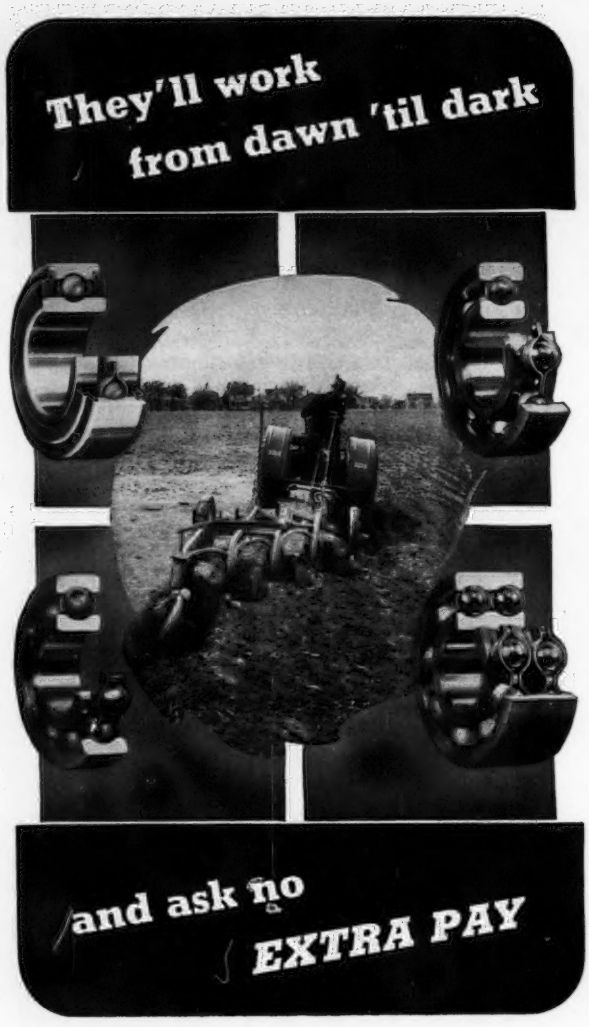

AMERICAN farms are going to be short-handed this summer as defense industries reach out for a bigger supply of intelligent men who know how to handle machines. Accurate, sturdy BCA Ball Bearings on the farm tractors, combines, harvesters, hammer mills and other fast-moving farm equipment will do their share toward keeping the work moving and costs down on the farms of America.

Every BCA Ball Bearing is designed right—made of the right materials for the service indicated in the BCA Data Book. A copy especially designed for drafting board use will be sent on request to makers and designers of farm equipment.

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Agricultural Engineering Digest

(Continued from page 156)

A SMALL PRACTICAL VINEGAR GENERATOR: A VINEGAR GENERATOR SUITABLE FOR THE FARM OR SMALL MANUFACTURER, *F. W. Fabian.* Michigan Sta. (East Lansing) Cir. 174 (1940), pp. 13, figs. 3. The generator described consists essentially of (1) a base made from a glazed T-tile having its opening close to the flanged end by filling with cement concrete to 0.5 in below the opening and with paraffin over the concrete flush with the opening and (2) the generator tower proper made from three lengths of plain glazed tile jointed first with paraffin sufficient to prevent attack of the vinegar upon the concrete and above the paraffin with concrete to strengthen the joints. The outlet is fitted with a paraffined wooden disk having an outlet opening for the vinegar at the bottom and two air inlets above. The tower filling used in the experiments here described was of beech shavings, sifted to remove the finer pieces and loosely packed to allow abundant air space. A distributing trough of two compartments dumping alternately was made from tin plate and covered with paraffin to prevent corrosion. This device is considered necessary to provide for even distribution of the cider over the shavings. The paraffin-coated funnel set over the top of the generator reduced loss by evaporation. The shavings were kept in place by top and bottom plates of paraffined wood provided with numerous 0.25-in holes. A bill of materials for generators made from 6- and 8-in tile is given, together with a tabulation of estimated costs of construction, indicating that the 6-in generator can be made for less than $7 and the 8-in generator for between $8 and $9. It is pointed out that these generators are adapted for from 5 to 50 bbl of cider and are not practical for either larger or smaller quantities.

The processes of charging the filling material (shavings or corncobs, the former being preferred if suitable shavings are available) with *Acetobactor aceti* and operating the generator are described, and comparative observations on the performances of the two sizes of the generator are reported upon. In all experiments the 8-in generator produced a much more rapid conversion, the vinegar reaching the same strength in several trials in one-third of the time required by the 6-in generator. The 8-in generator made 4 per cent or standard vinegar in 2 days from cider cut back 50 per cent with finished vinegar. It also produced a vinegar of 5.8 per cent strength in a little more than 3 weeks from unmodified cider stock. The method of cutting back with finished vinegar is recommended because of the much shorter time required for complete conversion.

PONDS FOR FARM WATER SUPPLY, *J. B. Davidson and C. H. Van Vlack.* Iowa Sta. (Ames) Bul. P17, n. ser. (1940), pp. 493-508, figs. 11. This bulletin is a review of the problems involved in the establishment and use of farm ponds and offers suggestions for their location, construction, and maintenance.

As a basis for estimating required pond capacity, the daily consumption per head of various livestock and the daily consumption per person in the use of a domestic water supply are stated. Capacities of round ponds having depths at the spillway of from 8 to 20 ft and a bank slope of 3 : 1 are tabulated, together with water available for use, calculated on the basis of 54 per cent loss by evaporation and seepage, and the drainage area needed to maintain a pond of each of the sizes tabulated. It is pointed out that runoff in drought years should be the basis for determining the watershed area required, and it is considered safe to accept an annual runoff figure of 2 in as such a basis. The tabulated drainage-area requirements are, therefore, based upon an annual 54,000 gal per acre, of which 25,000 gal (46 per cent) is estimated available for use. Surveying to determine high-water line and size of dam, earth-dam construction, sod and masonry spillways, outlet pipes, fences, etc., are also taken up.

Literature Received

Drainage and Flood Control Engineering, by George W. Pickels. Second edition. Cloth bound, XII+476 pages, 6x9 in, 153 illustrations, 61 tables. Indexed. The first edition, published in 1925, became a standard reference and text on the subject, and is now brought up to date by deletion of 95 pages of old material, replaced by 125 pages of new or revised material, and other additions of data developed since publication of the first edition. Chapters cover introduction, precipitation, flood runoff, stream discharge measurements, flow of water in open channels, flow of water in tile drains, land drainage by open channels, soil physics, underdrainage, pumping plants for drainage districts, flood protection by channel improvement, flood protection by levees, flood prevention by reservoirs, and drainage law. McGraw-Hill Book Co., Inc., New York. $4.00.

(Continued on page 160)

Good Soldiers!

The Zinc Industry, like a good soldier, is uniting in the effort for the common good. Its first obligation, in these times of grave moment, is to the Nation; the full resources of the Industry have been placed at the Nation's call. Complete satisfaction of all the Nation's needs for Zinc is the Industry's firm and declared purpose.

Important and multitudinous as are the uses for Zinc in the program for National Defense there still remains, after all defense needs have been met, an amount of Zinc which represents a substantial proportion of all that consumed in the United States in normal years by all industries.

The rapidly expanding demand for Zinc, both for defense and for non-defense purposes, has put a strain upon the Industry; but every agricultural engineer, as well as everyone who has the welfare of agriculture at heart, is assured that production capacity has been increased to the utmost since the conditions of the present emergency began to develop. Indeed, production now is not only far above all previous peaks, but the expansion is still going on.

The American Zinc Institute continues to offer its cooperation to educational and extension agencies, and welcomes opportunities to be of service.

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The INSIDE Story of Diesel TRACTRACTORS

WITH men who know machinery best, **quality** of materials and the **precision** with which they are used are important factors in measuring the performance capacity of any piece of equipment. Harvester engineers recognize this fact and act accordingly, throughout every step in the manufacture of International Diesel TracTracTors.

For example, connecting rods used in these tractors are drop-forged of alloy steel, piston pins are full-floating type, and crankshaft bearings are steel-backed and require no fitting to assemble or replace. These are some of the many distinctive engine features which tell the **inside** story of International Diesel TracTracTors—a story of **performance, economy**, and **long life** that is winning new friends wherever crawler power is used.

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LINK-BELT CHAINS

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Literature Received

(Continued from page 158)

Heating, Ventilating, Air Conditioning Guide 1941. Leatherette, xxiii+1120+96 pages, 6x9 in. Nineteenth edition. An extensive reference on the subject, with a technical data section and a manufacturers catalog data section, each separately indexed. The book also includes a membership directory of the American Society of Heating and Ventilating Engineers. Seven subsections in the technical data section cover principles; heating and cooling load calculations; combustion and utilization of fuels; steam and hot water heating; air heating, cooling, and conditioning; automatic controls, instruments, motors; and special applications and miscellaneous. American Socity of Heating and Ventilating Engineers, 51 Madison Ave., New York, N. Y. $5.00; with thumb index, $5.50.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

JUNIOR ENGINEER, ($2000). The U. S. Civil Service Commission announces an unassembled examination for junior engineers, any branch, to meet an increasing need for their services in national defense work. Persons who have eligible ratings under previous junior engineer examinations within the past year need not apply again, as their eligibility will continue during the life of the register resulting from this examination. College graduation in engineering is required, but applications will be accepted from senior students. Applications on Form No. 8 may be filed at the Commission's Washington office until December 31, but positions are open now and applications will be rated as received. The age limit is 35 years. Details are explained in announcement No. 51.

INSPECTOR, ENGINEERING MATERIALS (Aeronautical). The U. S. Civil Service Commission announces an unassembled examination for men for the above classification of work in the Navy Department, in ratings of senior inspector ($2600), inspector ($2300), associate inspector ($2000), and junior inspector ($2000). Optional branches include aircraft, engines, mechanical parts, aircraft propellers, instruments, tools and gages, materials, and parachutes. Experience in several of these branches need not have been acquired on aircraft work specifically. No closing date is set for filing of applications. Details are explained in announcement No. 54.

JUNIOR ENGINEERING DRAFTSMAN, ($1440). The U. S. Civil Service Commission announces an assembled examination for junior engineering draftsmen in the following optional branches: Aeronautical, architectural, civil, electrical, mechanical, structural, topographic, lithographic, and general. Age limit is 40 years. Applications on Form 8 should be filed at the Commission's Washington office by April 24. Details are explained in announcement No. 64.

RESEARCH WORKER wanted July 1st. Inauguration of a research program in farm equipment in the South will require graduate in agricultural engineering with farm background. Consideration given only to man with inventive and mechanical turn of mind who is not subject to Selective Service Act. Salary up to $3,000, depending upon qualification. P.O.-128

RESEARCH WORKER wanted. Inauguration of research program in farm structures in a southern state requires high type man with research experience. Problems in crop storages and animal shelters predominate. Consideration given only to man with farm background who can take the initiative and who is not subject to the Selective Service Act. Salary up to $2700, depending upon qualifications. P.O.-129

POSITIONS WANTED

AGRICULTURAL ENGINEER, with B.S. degree in agriculture and electrical engineering who is a candidate for B.S. degree in mechanical engineering in June 1941, and has 5 years of teaching experience in the field of agricultural engineering, desires position in research or extension with a college or manufacturing company. PW-334

AGRICULTURAL ENGINEER with special training in agricultural education including M. A. degree from University of Missouri, desires employment as instructor in farm shop, in soil conservation, or farm buildings, or as a construction supervisor. PW-335